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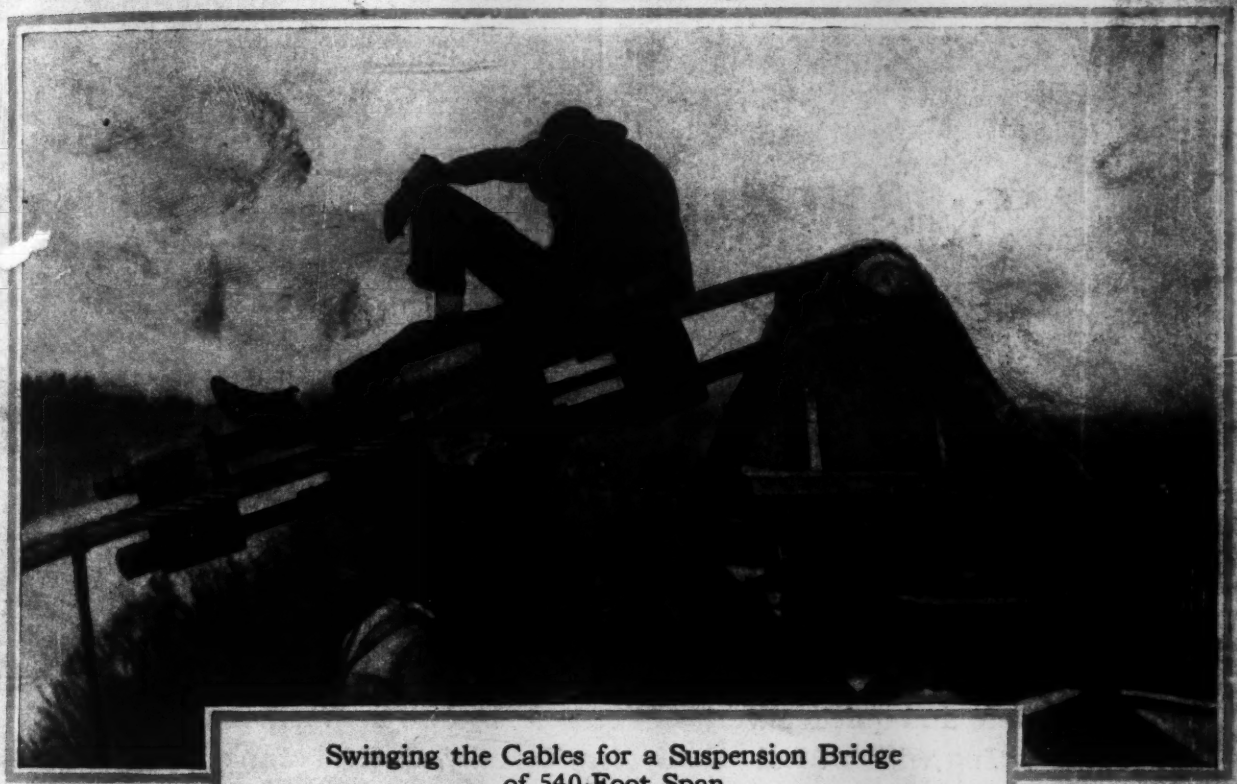


Swinging the Cables for a Suspension Bridge of 540-Foot Span

In this issue the designer of the Cumberland River suspension bridge tells of remarkably rapid erection and ingenious cable construction and adjustment. Ground limitations called for steep backstays, pin-connected to the saddles. The cable ropes, carried across separately on a messenger cable, were drawn up to equal sag by nuts on U-links at the saddles.

ALSO IN THIS ISSUE:

Meeting of American Society for Testing Materials

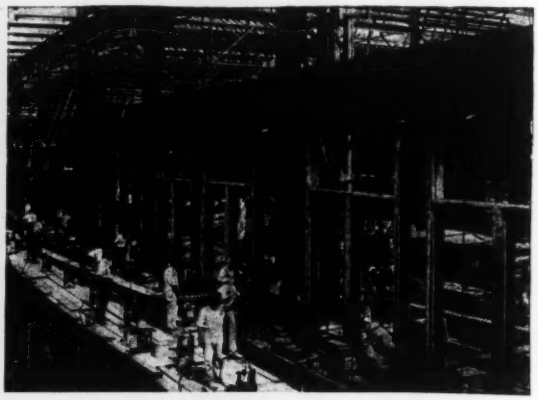
American Concrete Institute Convention

Spillway Capacities Required for Reservoirs in Western United States
By JOHN T. WHISTLER

Shipbuilding Equipment at Fore River

Engine Terminal Improvements: Pennsylvania Lines West

July 3, 1919



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Volume 83 July 3, 1919 Number 1

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Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS AND ENGINEERING RECORD, WITH WHICH IS INCORPORATED THE CONTRACTOR

E. J. MEHREN, *Editor*

CHARLES WHITING BAKER, *Consulting Editor*

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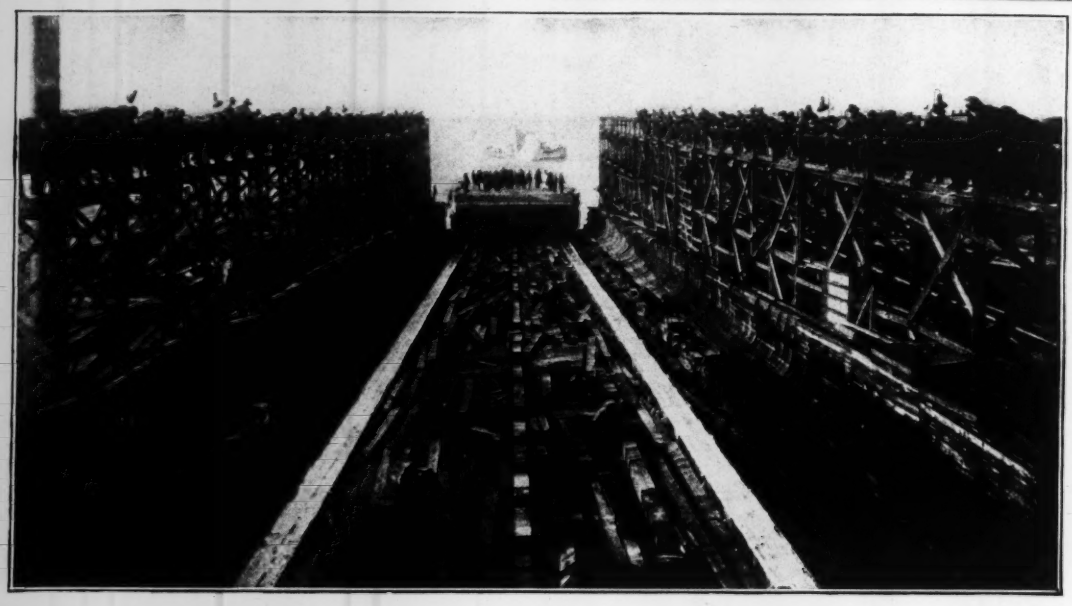

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E. J. MEHREN, *Editor*

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"Engineering News-Record" is a consolidation of "Engineering News" and "Engineering Record."

"Engineering News" was founded in 1874 by George H. Frost, as the "Engineer and Surveyor," which title subsequently became the "Engineer, Architect and Surveyor," then "Engineering News and American Railway Journal" and, finally, "Engineering News," under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

"Engineering Record" was established in 1877 by Henry C. Meyer as the "Plumber and Sanitary Engineer." The name was subsequently changed to the "Sanitary Engineer," "Engineering and Building Record" and, finally, to "Engineering Record." During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The staff of "Engineering News-Record" comprises

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Technical Revival

IN THE refreshing spirit which animated last week's meeting of investigators and engineers at Atlantic City, under the auspices of the American Society for Testing Materials, new vigor of technical thought found unmistakable expression. The strong program of technical papers which distinguished the meeting showed, too, that the society's vitality needs other outlet than merely through the laborious routine of committee work. Scientific study of test methods and instruments, and exploration of the properties of materials and their modification by different treatments, offer a field in which more brilliant performance may yet be achieved than ever recorded in the past.

Materials and "Recommended Practice"

MUCH of the development of the engineering art rests on the view that a construction material is something definite, something that can be specified and tested without regard to what use the engineer or constructor may subsequently make of it. Faithful adherence to this idea has created that large branch of the profession which deals with materials and their testing, has brought engineering construction to an efficiency and economy otherwise unattainable, and incidentally has made the American Society for Testing Materials flourish and grow. Now, however, in that very society more than one technical committee appointed for the purpose of defining and prescribing tests for a particular material, insists on preparing a code of practice for the use of that material. The tendency in this direction has recently increased in very marked degree. Is this a desirable condition? It seems to us that it presents a problem meriting the early consideration of the society's governing authorities, and possibly the exercise of some wise restraint. Singleness of purpose is necessary to give aim and sound guidance to the work of an organization as of an individual; and this would be endangered if the separation between the field of materials and the fields of engineering and construction were not scrupulously respected. The battles fought within a committee before a specification can be agreed upon must often range far enough to encroach on the field of construction. But such encroachment should be limited to the committee room. When a group of men appointed to draw specifications for sewer pipe, or for gypsum plaster, claim that they cannot proceed unless they are first allowed to write codes of engineering practice in sewer construction or hard plastering, the committee-room atmosphere extends beyond due limits.

Income and Expenditure

THERE is something sobering in the refusal of the American Society for Testing Materials to grant the money requested for support of the National Service Committee. But it will be clear that the society merely obeyed the dictates of prudence when it took this action. Its financial condition does not permit the extra expenditure. Living on a narrow margin of income, the society faces a greatly enlarged budget because of necessary changes in its business methods, already inaugurated. Obviously this is the sole motive for the unfavorable action which the society's executive committee took on the request for its share of a $25,000 budget; the society has expressed no views unfavorable to the National Service Committee or to the Engineering Council's action in establishing that committee. Under the circumstances it will be the more interesting to learn what the other member societies of the Council will do as to their share of the needed sum. It is known that some of them are almost as limited in financial ability as is the American Society for Testing Materials. An uncomfortable question will be raised if it turns out that the societies have, in effect, adopted a scale of living exceeding their income. Shall the newborn views of far-reaching society activity prevail? Or, shall the dictates of sound management be observed, by keeping expenditure within income? These questions deserve serious consideration.

Railway or Highway?

WHAT is the proper field of the railway and of the highway in the country's transportation system? To what extent has the coming of the motor truck rendered the branch line railway obsolete? How does the heavy cost of building and maintaining roads that will stand up under motor truck traffic affect the total cost of truck transportation? *Engineering News-Record* has just completed an investigation of these and related questions. The results of this investigation will be given at length next week.

How to Make Stucco

STUCCO, that is, the plastering of exterior wall surfaces, is as old as civilization, but it is one of those things which practice has not made perfect. Engineers and architects particularly are ignorant of its fine points, and the practical man—upon whom in most cases the application of stucco rests—has not benefited by the experience of his trade ancestors. Consequently, there is more poor stucco today than any other form of wall surface and the use of it is only in mild favor. In spite of this, good lasting stucco can be made if proper attention is paid to details. Its application is an engineering operation and deserves the consideration of the technical man. To such of these as are still of the opinion that the plasterer is the real judge of stucco application, the report of the Committee on Concrete Surfaces of the American Concrete Institute, presented last week, should be a revelation. Seldom has there been a more complete study of a single subject nor one which, if properly assimilated, will do more to improve a detail of engineering construction.

Regulating Design by Standard Rules

AMONG the five bridge specifications summarized on another page, one is a specification which was drafted for country-wide use. It was meant to be adopted by all railway bridge engineers and to regulate the construction of railway bridges throughout the country. In this purpose it has not succeeded, though it has had wide currency—more largely as a code of bridge-design principles than as a purchase specification. Every railway of importance has its own specification, such as those of the Pennsylvania, of the Southern Pacific, and of the New York Central, summarized in our table.

Present tendencies would indicate that this condition will continue. If, however, bridge practice all over the country is to come under the sway of a single design specification, it is worth while giving heed to authoritative opinion on the subject.

A railway engineer of unusually long experience says of standardized design codes: "Standard specifications are a curse. They divest the individual engineer of responsibility and make him work to rule rather than to conscience." This remark strikes at the root of the case; it is the more weighty because the complexity of the subject has given rise to not a few misconceptions about standards, and particularly standards that tend to control engineering practice.

It is imperative that the methods of engineering practice should be so shaped and so maintained as to stimulate original thought, initiative, and individual study of the specific problems presented. Efficiency cannot otherwise be assured. Routinization of engineering is bound to sap the foundations of the art. It is in this sense that rules to control engineering design are harmful: they tend to discourage and to check original thought.

The considerations here suggested are of serious import to the future development of bridge construction. They cannot be met by mere insistence on the abstract desirability of standardization. Unquestionably a record of the conclusions and judgments developed by experience in bridge construction and maintenance, those conclusions which represent the sum of bridge knowledge, should be briefed in a document available for the general guidance of bridge engineers. But shall such a document take the form of a rigidly drawn set of rules, or shall it be modeled on another pattern? This is the essential problem presented.

Cracks in Rail Steel

STUDY of rail quality has progressed since the publication of the first results obtained by the new deep-etching method three months ago. The method is now acknowledged to be a powerful instrument of investigation, one which, by furnishing an additional method of observation, brings out new truths through correlation now with one set of phenomena, now with another. It is rapidly linking up a chain of evidence that promises to tie together rail failures and steel quality.

Evidence already collected tends to establish the view that fine cracks in steel are responsible for the gashes produced by the hot acid used in the deep-etching method; at any rate it makes this a good working hypothesis. These gashes, again, have been shown to be intimately related to both fissures and the "gray spots" which always accompany fissures. Thus a condition in which the steel is broken by numerous internal cracks, a "shattered" condition of the metal, as some of the experts call it, is concluded to be associated with rail breakages, and is assumed to be the cause of these breakages. Various other explanations of transverse fissures have failed to satisfy the facts. It has been claimed, for instance, that gagging is responsible for the origin of the fissures; but the internal cracks revealed by etching are sometimes located near the end of the rail, and fissures are also often found in this neighborhood, while gagging affects only the middle part of the rail's length. Moreover, gashes have been developed in specimens taken from tires and wheels, metal that is not gagged.

If the etching gashes are cracks, they are analogous to "snowflakes" in gun forgings, which in a very careful and sharply reasoned study by H. S. Rawdon some months ago were shown to be most probably cracks in the metal. It has been claimed by others that non-metallic inclusions or the like are responsible for snowflakes; and the same explanation has been given for the nuclei of transverse fissures in rails and for the gashes in rails. But there are very great difficulties in the way of believing in the existence of large films of such inclusions, so distributed and so numerous as are the gashes in rail steel, and equal difficulties in the way of understanding the mechanism by which the hot acid could convert the inclusions into such gashes as develop in rail metal. It happens also that some of the

gashes appear precisely in those locations where the deformation of the steel during the rolling process might be expected to produce tension cracks.

From the facts now accumulating, the most likely direction of progress in rail study leads through research in the production and the prevention of cracks in rolled material. The metal composition, ingot conditions, the heat treatment of the steel, and the rolling and cooling are all involved here. Such research would show whether the weakness of the metal *per se* or shrinkage or tearing actions are mainly at fault, and it should then be easy to decide whether improvement must be made in the steel chemistry or in the manufacturing procedure, or, possibly, in both.

Both the American Railway Engineering Association and the American Society for Testing Materials have now concerned themselves with the new rail study, and the subject thus creates a new bond between these, the most active technical societies of the country. Partly because of this fact there is extensive coöperation between metallurgical investigators, railway engineers, manufacturers and laboratory scientists, a condition warranting high expectations for early solution of the mysteries surrounding rail quality.

Progress in Engineering Education

THOSE who have criticised the society for the Promotion of Engineering Education in the past for failure to attack its problems by the scientific method, and for its tendency to deal with opinions rather than facts, will find cause for encouragement in the report of the 27th annual meeting printed in our news pages this week. Definite evidence that the society is rising to meet the greatest opportunity in the history of engineering education—the combination of the war experience with the epoch-making report by Dr. Mann—are seen in several resolutions of the utmost significance for the future. Local sections of the society are to be established. Committees were created to coöperate with national engineering societies and to develop classifications and specifications as to the preparation and qualifications for egineers. Recommendations were made for the immediate adoption of intelligence tests. A distinct new tendency to seek first-hand information, such as results from experience or direct investigation, is seen. Enthusiastic interest was aroused by the description of the "case system" used in law and medical schools and its application to engineering as carried out in the Army Engineer School at Camp Humphrey, at Tufts College and elsewhere. One of Dr. Mann's major recommendations—that greater emphasis should be placed upon values and costs—received, however, wholly inadequate discussion, despite the two-day session in Washington on the subject of business training for engineers which preceded the Baltimore meeting.

The intelligence tests, recommended both at admission and to be applied throughout the course, if applied with "gumption" and commen sense as supplementing the usual examinations, have shown valuable results. The correlation coefficient, as determined at the Carnegie Institute, and the graphical charts there developed, have indicated clearly whether bright students are working to their maximum possibilities, serving also as a test of the teacher's success in arousing his class. These tests can be developed to determine the aptitudes of the students and most effectively aid the teachers' judgment in deciding questions of discipline or dismissal for low scholarship records.

Most pregnant in its possibilities for the future of education and of the profession is the development in the application of the conorete-problem method, somewhat similar to that described by Professor Morrow, of Yale University, in our issue of April 24, 1918, p. 827. This method requires teachers with initiative, wide practical experience, and special qualities of mind and soul. Students and teachers both are described as being "on their toes" all of the time. As often mentioned at the convention, sufficient salaries to attract the proper type of teacher must be provided. In this connection, it should be remembered that the salaries now offered of say $1800, $3000, $4000 per annum, at present really correspond respectively to only about $1200, $2000, and $2700 at pre-war prices. The most effective education, that of master and disciple, urged in the address by President Hollis, of the Worcester Polytechnic Institute, cannot be developed by men paid for half time who give full time to outside practice, as he so aptly expressed it. The teachers should be relieved of administrative duties and given leisure to develop their courses and their students, as well as pursue research in practical lines. The recent announcement that Cornell University has increased teachers' salaries about 20 to 33%—at the same time increasing tuition fees—and that Harvard plans a $10,000,000 endowment to allow an increase of 25% in teachers' salaries, is an encouraging sign.

The claim made for the project or "case" system of teaching that it will help to develop the "engineering mind" appears to be in process of fulfillment, if the enthusiasm expressed by those who have had intimate contact with the work done in this line is any criterion. To satisfy the double demand of the profession for engineering leaders and for the rank and file, employers and employees—the new methods seem to have great inherent possibilities. The students are aroused to their best efforts; in fact, these new methods are carrying back the true research idea into direct contact with the problems of the engineering world.

One of the live issues of the day which was not given sufficient place in the convention is that of raising the profession to a higher status in the social structure. The general trend toward closer relations between the engineering educator and the profession should prove to be a fruitful element of progress in this direction. In fact, if followed to logical conclusions this awakening points to the responsibility of the profession to enter the business world and furnish places for the greater number of trained leaders which engineering education should develop. As an aid to the true attitude toward engineering on the part of the students, outside specialists should be called to address the student organizations. These organizations should be given every support by the teachers, and used to develop that character, self-confidence, and leadership which the profession needs, giving college credit for such activities.

The inflow of new life from our engineering schools would in a few years raise the profession to that higher position it desires. May the promise of these new developments have rich fulfillment!

Special Design Features and Erection Methods For 540-Foot Suspension Bridge

Cumberland River Foot-Bridge for du Pont Engineering Company, Near Nashville, Was Designed With Varying Cable Inclinations at Towers

By William G. Grove

Assistant Engineer, American Bridge Company, New York City

THE design of the 540-ft. highway suspension bridge, over the Cumberland River near Nashville, Tenn., for the du Pont Enginering Co., contains somewhat unusual features. Owing to the height of towers, and also to the location of a railroad and some telegraph wires on one bank, the angles of inclination of the anchorage cable and main cable at the towers were made different. As the cable stress has a constant horizontal component from anchorage to anchorage, the different angles of inclination required heavier cables for the anchorage than for the main span and, in order to save expense, the cables, instead of being continuous as is normally the case, were made in three separate units. The lengths of the anchorage cables necessitated special consideration for the placing of the shoes and rollers on top of the towers, so as to allow for free movements due to deformation both during erection and under traffic.

Description of Site—The du Pont plant is situated about eight miles from Nashville by electric line, but on the opposite side of the Cumberland River from the trolley. Until 1918 there was only a ferry crossing at the site, and in order to provide a more easy and convenient access to the plant the du Pont company decided to build a foot-bridge across the river. The normal traffic would be from the electric line over the bridge into the plant in the morning and from the plant over to the electric line in the evening, so that the bulk of the traffic would be in only one direction at any one time. It was therefore decided to make this bridge with a clear width of 8 ft., which would be ample for one-way automobile passage in the middle of the day when there would not be any congestion due to pedestrian traffic.

The river at ordinary stages is about 25 ft. deep, and the east bank is 40 ft. and the west bank 60 ft. above normal pool level. During high-water stages the river overflows the east bank regularly, and it was decided to make the underclearance of the span 90 ft. above normal pool level. This condition, indicated by Fig. 1, brought the floor of the bridge 50 ft. above ground on the east bank and 30 ft. above the west bank, and to provide access to the bridge, therefore, the du Pont company built a wooden trestle approach at each end of the structure.

Design of Bridge—For light highway suspension bridges the sag of the cable is usually made from one-tenth to one-twelfth of the span length, and in this case, to keep the height of towers as small as possible, the ratio of one-twelfth was adopted, thus giving the cables a normal sag of 45 ft., based on a span length of 540 ft. With this value of sag the height of the towers became 100 ft. for the east tower and 80 ft. for the west tower.

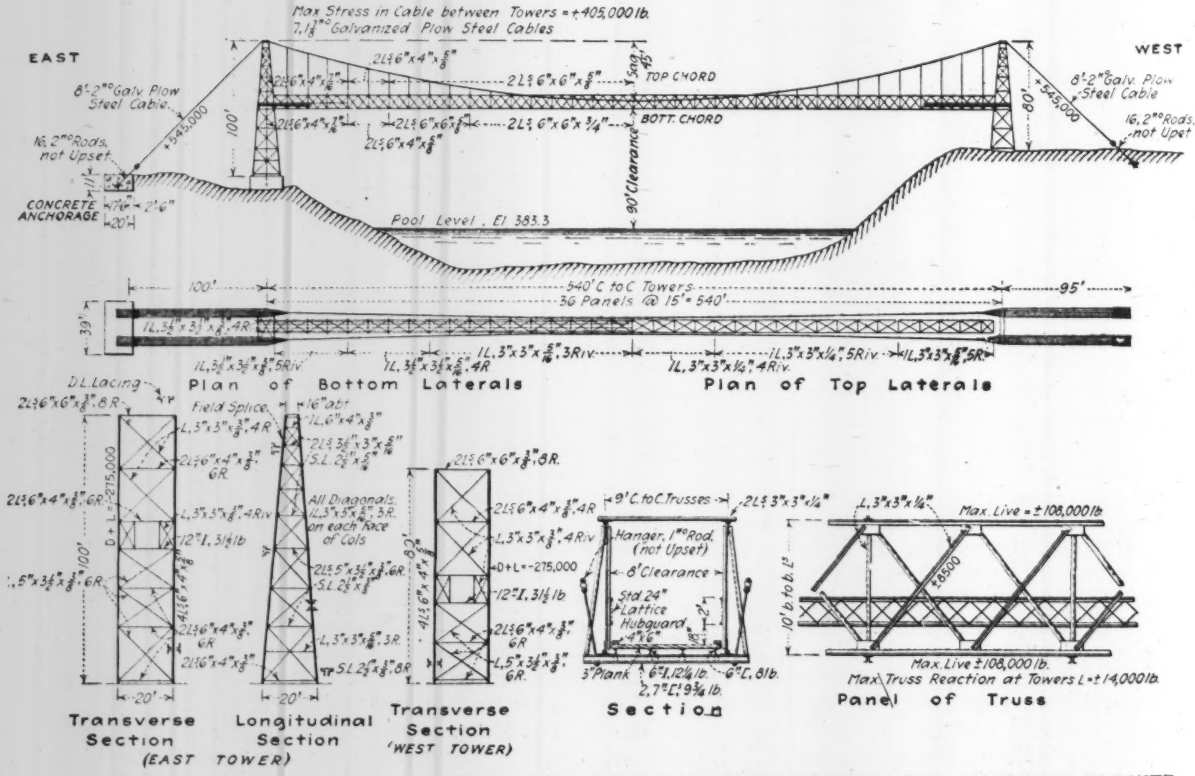


FIG. 1. GENERAL DIMENSIONS AND SECTIONS OF 540-FOOT SUSPENSION BRIDGE OVER CUMBERLAND RIVER

In a light suspension bridge, as ordinarily designed, the horizontal component of the cable stress is constant from anchorage to anchorage and the cable stress is maximum at the towers. In order to use a continuous cable between anchorages, the angle of inclination of the anchorage cable to the tower is made the same as the angle of inclination to the main cable of the tower. In the present bridge, to keep the inclination of the cable to the tower the same on either side of the tower would mean that the cast anchorage would be 300 ft. and west anchorage 240 ft. from the base of the towers, respectively. The anchorage portion of each cable would thus become extremely long, amounting to 320 ft. for the east and 250 ft. for the west cable. Not only would these lengths be excessive, but, on account of the conditions at the west bank, the anchorage cables would foul the line of the Louisville & Nashville R.R. and also some telegraph wires paralleling the road.

On account of these difficulties, it was decided to locate the west anchorage in such position as to be clear of both railroad and telegraph wires, and a location was determined upon giving an angle of inclination of west anchorage cable to tower of 45°. In order to preserve symmetry of appearance, the angle of inclination of the east anchorage cable to the tower was also made 45 degrees.

The floor was designed for a live load of 80 lb. per square foot or a three-ton automobile in addition to its own dead load. The trusses were designed for a continuous live load of 400 lb. per linear foot of bridge of such length and in such position as to cause maximum stress for the individual truss members, based on the assumption that the stiffening truss serves to distribute the live load in any position on the bridge equally to all the hangers and so give a uniform load on the cable. On this assumption, the ends of the trusses are subject to positive and negative reactions, depending on the position of the live load. The cables and towers were designed for a continuous live load of 400 lb. per linear foot of bridge in addition to their own dead weight.

The maximum stress in the main cable between the towers is 405,000 lb., the maximum horizontal component of which is 385,000 lb. This horizontal component being constant from anchorage to anchorage, the maximum stress in each anchorage cable is 545,000 lb. The two anchorage cables are approximately 140 ft. and 110 ft. long, respectively, while the main span cable is about 550 ft. in length. To use a continuous cable from anchorage to anchorage of sufficient strength for 545,000 lb. of stress would mean that the main-span portion would have a greater margin of safety than the anchorage portion, and as the main-span portion is twice as long as the sum of the two end portions there would be a considerable waste of cable and consequently of money.

The cables were therefore made in three separate lengths, the two anchorage cables of sufficient strength for 545,000 lb., and the main-span cable good for 405,000 lb. Using galvanized plow-steel wire rope with a factor of safety of 5, based on the approximate breaking stress determined from results of tests, it was necessary to adopt seven ropes of 1¼-in. diameter for the main-span cable and eight ropes of 2-in. diameter for each anchorage cable. Seven ropes were used in the main-span cable, as that number more easily lends itself to clamping into one cable at each hanger connection, so that the general appearance of the seven cables when clamped every 15 ft. is of one large cable, as in Fig. 2. From the end hanger to the top of the tower, the seven individual ropes are splayed out so as more easily to make a connection there.

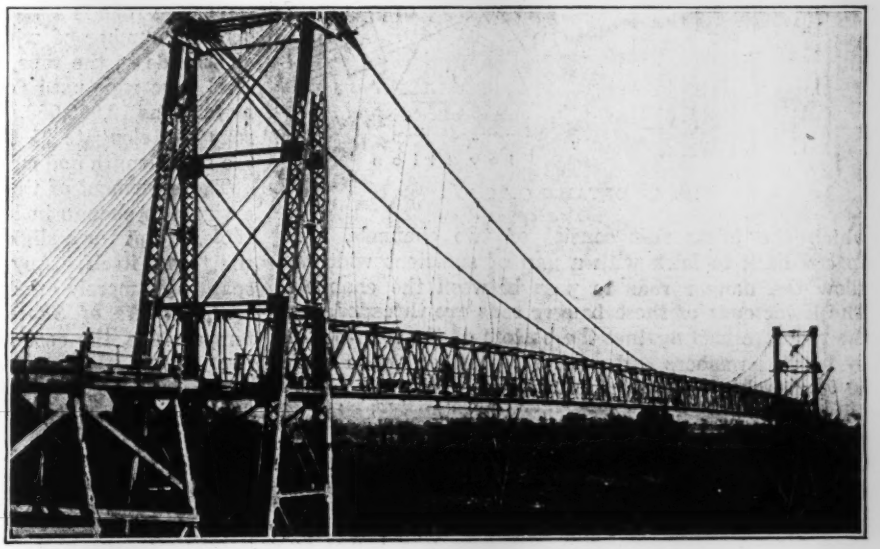


FIG. 2. TRESTLE APPROACH, TOWER AND ANCHORAGE CABLES IN FOREGROUND

Eight ropes were used for each anchorage cable, as this number not only permitted the use of smaller individual ropes, but also provided for a more symmetrical connection at the top of the tower than could have been made by the use of seven ropes in the anchorage cable. The eight anchorage cables and the seven main-span cables were connected to a pin in a cast-steel shoe shown in Fig. 3. This shoe rests on 2¾-in. rollers on top of the tower, the rollers providing for free movement of the span during and after erection due to stress

FIG. 3. CAST STEEL SHOE AT TOP OF TOWER

and temperature changes. Details are indicated in Fig. 4.

Floor System—The floor is of the ordinary type of construction for light highway bridges, consisting of plank floor resting on steel joists. The floor-beams on

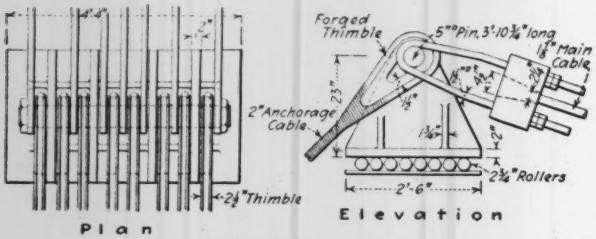


FIG. 4. DETAILS OF SHOE

which the joists rest consist of two channels, each spaced back to back with a gap of sufficient width to allow the hanger rods to pass between the channels. The lower ends of these hanger rods are threaded, and the rods are held against the bottom of the floor-beams by beveled washers and nuts. The trusses were made 10 ft. deep back to back of flange angles, this depth permitting the use of overhead lateral bracing. The top of each truss was further stiffened by a kneebrace at each panel point extending from the top flange to the end of the extended floor-beam.

The towers were made 20 ft. wide so as to give sufficient stability against wind pressure, which was assumed at 25 lb. per square foot on the unloaded and 10 lb. per square foot on the loaded structure. For anchorage, the tower was made safe against wind pressure of 50 lb. per square foot on the unloaded structure. The distance center to center of hangers where they connected to the floor-beams was made 10 ft. 3 in., and as the distance center to center of cables at the top of the towers was 20 ft., each cable with its suspender rods was cradled. This provided additional rigidity against lateral forces.

Anchorage—The total stress in the eight anchorage cables for each truss is 545,000 lb., or 1,090,000 lb. for the entire anchorage, the vertical component of which is 770,000 lb. Ordinarily, in suspension bridge designs, it is customary to provide an anchorage good for 50% in excess of the maximum uplift, which total amount in this case is 1,150,000 lb. The east anchorage, accordingly, consists of a block of reinforced concrete 20 ft. wide by 11 ft. deep by 39 ft. long, this mass of concrete at 135 lb. per cubic foot weighing approximately 1,150,000 lb. The concrete is embedded in the earth in such a manner that the maximum pressure on the soil in front of the anchorage from the maximum horizontal component of the anchorage cable stress is 3600 lb. per square foot. The cables were fastened to 2-in. diameter rods embedded in the concrete, two rods being attached to the cast-steel socket of each of the eight individual cables for each truss. These rods in turn are connected to channels near the bottom of the concrete anchorage.

The ground on the west bank is limestone rock, and here it was the intention merely to embed the anchorage rods into the limestone, provided the rock was solid. It was found on excavation, however, that the rock was very poor, so the du Pont company built a concrete block the same as that at the east end. Fig. 5 shows this anchorage.

The most important feature in connection with the preparation of the detail drawings was the determination of the movements of the cast-steel shoes on top of the towers and the amount that the main-span cable should be shortened in order to provide the proper sag under full live load.

The modulus of elasticity of structural steel is approximately 30,000,000. The modulus of elasticity of steel wire rope is a variable quantity, depending on the lay, the number of wires in a strand and the number of strands in the rope, and an average value for plow-steel wire rope used for suspension bridge cables may be taken as 12,000,000. It is seen, therefore, that a wire rope will elongate 2½ times as much as a steel bar of the same length and subjected to the same unit stress.

The movement of the shoe on top of the tower is due entirely to change in length of the adjacent anchorage cable, except for a slight amount due to the deflection of the tower itself. Any change in length of the main-span cable merely affects the sag of the cable itself.

Movements of Shoes on Towers—Assuming normal temperature, the east anchorage cable will elongate 2⅞

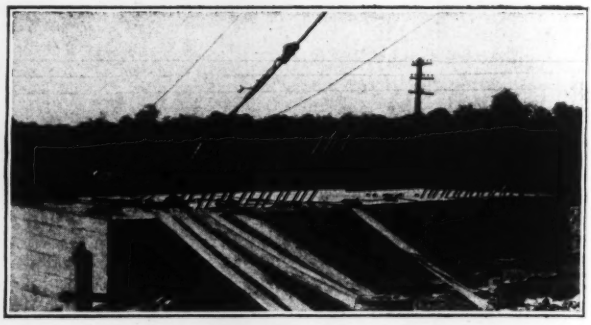


FIG. 5. CONCRETE ANCHORAGE WITH EMBEDDED STEEL RODS

in. under dead load and an additional 2 in. under full live load, making an increase in length of 4⅞ in. The east tower will shorten ¼ in. under dead load and $\frac{3}{16}$ in. under full live load, making a total shortening of $\frac{7}{16}$ in. The horizontal movement of the shoe due to elongation of the cable and shortening of the tower will be 4¼ in. for dead load and 3 in. for full live load, or a total horizontal movement of 7¼ in. from the no-load position to the dead plus full live load position. It is customary to let the center of the tower bisect the movement of the shoe for live load, so that in this case the position of the shoe at the time of erection under no-load stress in the anchorage cable was 4¼ in. plus 1½ in. = 5¾ in. off the center of the tower back from the river. The no-load length of the east anchorage cable was made 138 feet 5 inches.

In a similar manner, under normal temperature, the shoe on the west tower at the time of erection was placed 4½ in. off the center of the tower, and the no-load length of the west anchorage cable was 11 feet. 1 inch.

Based on 540-ft. center to center of towers, the horizontal distance center to center of shoes for the no-load or erection position was 540 ft. 10¼ in. This decreased to 540 ft. 2¾ in. for the dead-load position and 539 ft. 9¼ in. for full live-load position. It was desired that the sag of the main-span cable should be 45 ft. under full live load. The length of the parabola having a sag

of 45 ft. and a chord of 539 ft. 9¼ in. is given thus:

$$L = C[1 + 8/3\ (S/C)^2 \ldots .]$$

where L = the length along the curve, S = the sag and C = the chord. L was found to be 549 ft. 7¾ in., which is the length of the main cable under full live load. The main cable elongated 10¼ in. under dead load and an additional 7½ in. under full live load, making a total elongation of 1 ft. 5¾ in., and, based on the distances center to center of shoes given above, the no-load cable sag was 38 ft. 6 in. and the dead-load cable sag 42 feet 3 inches.

The above figures are all based on a normal temperature of 55° F.; for a minimum temperature of 0° the east shoe would move back $\frac{7}{16}$ in. and the west shoe $\frac{5}{16}$ in., while for a maximum temperature of 110° F. the shoes would move forward these amounts. The sag of the main cable would be decreased by 7 in. at minimum and increased by 7 in. at maximum temperature for any condition of loading.

Erection—The total time of erection was 12 weeks, but the actual time required to place the permanent material was only six weeks. The east and west towers were erected simultaneously by gin poles, Fig. 6, which were lifted to timber supports resting on the bracing struts of the towers for placing the upper members of the towers, shoes, anchorage cables and main cables, the shoes being clamped into position 5¾ in. and 4½ in. back of the center of tower for the east and west shoes respectively. (See Fig. 3.). The anchorage cables were lifted into place singly, and the 5-in. shoe pin was driven through the thimbles of the anchorage cables and the ribs of the shoe, the U-bolts for connection to the sockets of the main-span cables being placed at this time on the pin.

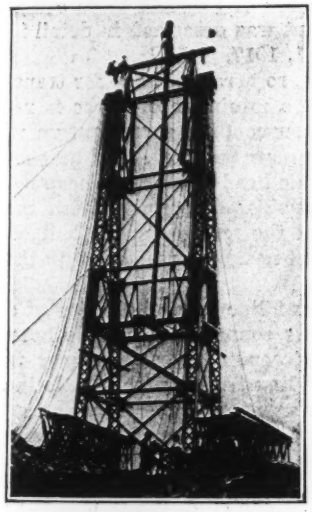


FIG. 6. TOWER ERECTION

The concrete anchorages were built by the du Pont Engineering Co., and in these anchorages were embedded the steel rods for connection to the sockets at the lower end of the anchorage cables. These anchorage cables were then connected to the rods, each cable socket being fastened to two rods by nuts, Fig. 5, by means of which the cables were adjusted until the entire eight anchorage cables were carrying approximately equal stresses.

For erecting the main-span cables a 1-in. wire rope working cable was stretched from tower to tower. Each of the main cables was 542 ft. long and weighed 3500 lb. These were seated on the ground in the rear of one tower and unwound from the reels. One end of the main cable was lifted to the top of the tower, and this end was then hauled across the river to the top of the opposite tower, the cable being supported from the 1-in. working cable by blocks attached at intervals of about 60 ft., thus preventing too much sag. The cable was then

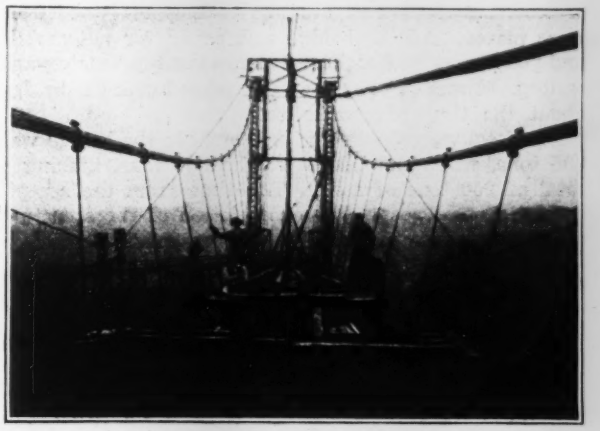


FIG. 7. CABLE CLAMPS AND HANGERS PLACED FROM WORKING PLATFORM

lowered to approximately correct position, and the sockets were pulled over the U-bolts attached to the tower shoes, as shown in Fig. 3.

The remaining six cables of the south main cable were then stretched in a similar manner, after which the seven cables in the north main cable were placed. A straight-edge with a spirit level was laid across all 14 cables, this straight-edge being on the fixed line of sag determined by a transit in the tower at the floor level. The cables were then adjusted by nuts at the end of the U-bolts, until all of them touched by the straight-edge.

After all the cables were stretched the 1-in. wire rope working cable was at the north main cable. Another 1-in. wire rope working cable was stretched from tower to tower over the south main cable and a working platform was supported from these 1-in. cables, the platform being controlled by ropes attached to each end. The cable clamps and hangers were placed by men on the working platform, Fig. 7, beginning in the center and working toward each end. A boatswain chair was used to carry out men and tools.

The floor system was also erected by men on the working platform, in this case beginning at the ends of the bridge and working simultaneously toward the center, the material being carried out to position by the boatswain chair. The platform was removed after the floor system was placed, and for erecting the trusses one of the 1-in. wire rope working cables, placed at the center of the bridge, was used as a trolley cable. The truss sections were brought to position on this working cable and erected by workmen on the floor system, the trusses being erected simultaneously from each end toward the center Fig. 8 shows the placing of the last truss section at the center of the bridge.

FIG. 9. TOP LATERAL BRACING

After the center sections of trusses were

erected, the top lateral bracing, railing and wood floor were placed, and the bridge was ready for automobile and pedestrian traffic. Fig. 9 shows the top bracing and railing. About 14,000 men a day passed over the bridge about the time of completion.

The total weight of structural steel in the bridge was 205 tons, while the cables weighed 45 tons, making a total of 250 tons of steel. The time from the acceptance of the proposal to the completion of the structure was about seven months.

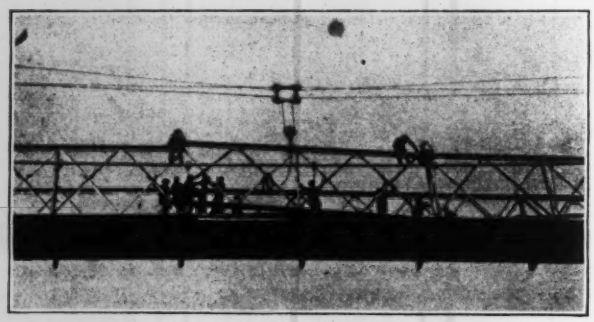


FIG. 8. PLACING LAST TRUSS SECTION AT CENTER

The bridge was designed by the writer, assistant engineer in the New York designing office of the American Bridge Co., under J. E. Wadsworth, division engineer. The detail drawings and the fabrication of structural steel were done at the Ambridge plant, R. G. Manning, engineer, and the bridge was erected by the Western Division erection department, K. L. Strickland, division erection manager. The cables were fabricated by the American Steel & Wire Co. at its Worcester plant.

Cost, Maintenance and Life of Highways

In a discussion of American highways before the American Society of Civil Engineers, Apr. 16, 1919, H. Eltinge Breed, first deputy highway commissioner of New York, made the following classification of highways as to cost, maintenance and life. These data represent the average experience in New York State, during 1917, on roads having a 16-ft. surfacing and a 26-ft. width between ditches. Mr. Breed called attention to the fact that since 1917 the highway traffic conditions have become much more severe, and that the maintenance cost will probably be increased, while the life will be shortened. As may be seen from the table, the maintenance on other than what may be considered hardsurface types is very heavy.

AVERAGE COST AND LIFE OF ROADS OF THE 16-26-FOOT SECTION IN NEW YORK STATE

Name	Thickness In.	Average Cost Per Mile — First Cost	Maintenance Cost per Year	Average Life, Years
1. Waterbound macadam	9	$23,000	$970	7[1]
2. Bituminous macadam	9	28,500	412	9[1]
3. Concrete	6	31,200	112	15[2]
4. Brick—Sand-cushion type	10½	....[3]	222	12[2]
5. Brick—Monolithic types	7 to 8	50,600[4]	....[5]	..[5]
6. Asphaltic concrete	7	40,000	245	..[5]

[1] Less than 1,000 tons per day of traffic.
[2] Estimated.
[3] Ceased to build this type before 1917.
[4] First cost under 1919 conditions, no previous figures.
[5] No figures available on account of short time used.

Economy Kinks in Water-Works Operation in Omaha

H. V. Knouse, Superintendent, Describes How Coal Is Purchased, Alum-Cake Plant Operated and Trucks Utilized

BUYING of coal on its evaporation qualities, coagulant made on the job, folding ditch barricades, truck attachments, and foremen's maps, are items utilized by the Metropolitan Water District of Omaha, Neb., to effect economies in operation. They were described in a paper by H. V. Knouse, assistant superintendent and purchasing agent, at the recent meeting of the Southwestern Water Works Association at Kansas City, Mo.

Every element entering into the operation of the pumping station is measured, and a daily report is laid on the desk of the superintendent each morning, showing in a final analysis a statement as to the foot-pounds developed per pound of steam in each engine, the amount of water evaporated, and the amount of water pumped per pound of coal. Adjustments are made at once. Coal of all kinds has been tried, so that the evaporation record can quickly be balanced against prices quoted by coal salesmen.

The home-made alum-cake plant is now in its third year of satisfactory use, said Mr. Knouse. Bauxite comes from Arkansas and acid from Kansas City, Kan. Coagulant costs 60c. per hundred and represents a yearly saving over a bid of $1.32 per hundred offered in 1916 for a three-year contract of $15,000. The equipment cost $6500. [The plant was described in detail in *Engineering News* of Jan. 11, 1917, p. 54.]

A folding ditch barricade, so arranged that for transportation from yard to job a minimum of space is required, with provision for suspending a red lantern in a secure manner, and being so painted as to be conspicuous under an automobile head light, is a cheap device that has proved of considerable value. With the lantern supported on top of the frame and the bail removed, the lanterns were not nearly so popular with the early morning milkmen.

A tee placed in the exhaust line from the motor of a two-ton truck, to which was connected a flexible hose, often saves the expense of sending for a steamer to thaw out a hydrant. Providing trailer couplings to the trucks for attaching tool wagons, and the mounting on wheels of mixers, large pipe trailers, trench pumps and other tools, save much time.

Foremen are furnished with a map specially made for them, drawn on a scale of 600 ft. to the inch and cut into sections covering one mile by two miles. Printed on cloth and bound with a cover having a snap clasp, the map fills a space 3 x 3 x 11 in. Mains, valves and hydrants only are shown, with numerals alongside to indicate sizes.

St. Paul Water-Works Operating Data

Of 40,721 water service connections in St. Paul, Minn., 91.8% are metered. The percentage of receipts from the sale of water through metered service exceeds the percentage metered by 0.3% only. Of the domestic and industrial consumption 97.7% is metered, while 65.8% of the total consumption, 77 gal. daily per consumer, is metered. Plus interest on bonds and sinking fund, the total cost of supplying water is $69.24 per 1,000,000 gallons.

Meeting of American Society for Testing Materials

New Era Inaugurated — Society Decides on Independent Headquarters and Expands Its Coöperative Work—Strong Technical Program—Development in Steel and Concrete—Marburg Memorial Meeting

A NEW era in the life of the American Society for Testing Materials was inaugurated by the 22nd annual meeting, held last week at Atlantic City, N. J. The significant development of the meeting was great expansion of coöperative work with other societies and with testing and research laboratories. Renewal of vigor in materials study was apparent, not only in the unusually strong program of papers presented, but also in announcements of work in progress or to be undertaken.

New policies were fixed by several decisions of vital importance which the Executive Committee reported to the meeting, though matters of great moment are still in abeyance. A definite organizational policy has been established, with the first independent headquarters in the society's history. C. L. Warwick, long the assistant of the late Professor Edgar Marburg, secretary of the society since its foundation, has been appointed secretary-treasurer to succeed him. The society's office will no longer be at the University of Pennsylvania, but is to be located in the building of the Engineers' Club of Philadelphia, 1315 Spruce St., and is to be manned by a full-time organization. During the past year the society has gone outside the close bounds of its technical activities by joining Engineering Council and by participating in the formation of the American Engineering Standards Committee. Both of these new activities have brought into being very serious problems, not yet solved. Furthermore, many demands for taking up joint committee work in different technical subjects arose after the end of the war, and they led finally to the society's entering upon a much broader program of coöperation than has prevailed at any previous time since its organization. All these matters produced active anteroom discussion at the meeting, but in the sessions of the society attention to the questions at issue was restricted to brief announcements by the chairman, with no discussion.

While these matters were in the foreground of attention, notable technical work constituted the essence of the meeting. In the matter of steel rails, results were reported that give distinct promise of early advance in this difficult subject. A classic group of papers on magnetic study of steel quality was presented. Fatigue and impact testing were brought into new prominence. Several ingenious new testing instruments gave further proof of the activity of laboratory investigators. In cement and concrete, work of exceptional importance was brought to the fore. A paper on paint tests injected new vitality into the lagging thought in this subject.

Council and Standardization

One result of Engineering Council's establishing a National Service Committee with Washington headquarters was a request to its member societies for appropriations totaling $25,000, to pay the expenses of that committee. J. Parke Channing, chairman of the council, guaranteed the sum, but it was desired to take up the guarantee. Of the $25,000 total, $1400 was asked of the American Society for Testing Materials. The society's executive committee, however, found itself financially unable to accede to this request. In reporting its action to the meeting, it did not define further its attitude toward the council or toward the National Service Committee, nor did the meeting enter into discussion of the subject.

A burning question was presented in connection with the American Engineering Standards Committee, whose proposed reorganization was reported in these columns two weeks ago. To review the situation in a word, the society voted a year ago to participate in the formation of such a committee, and in consequence the committee was organized last October. Within three months thereafter, however, it conceived doubt as to the effectiveness of its form of organization, and therefore began studying how to reorganize on a much broader plan than that previously authorized by the societies. It had in the meantime done no work on standards, nor had it taken steps to make its existence known to the technical world, in consequence of which the conferences on reorganization worked themselves out virtually behind closed doors. The result was that on May 17 the committee adopted a new constitution, which thereupon was laid before the boards of the societies for approval. First action in the matter fell to the American Society for Testing Materials, which, it happened, was also the only society in which the original proposal for a Standards Committee was submitted to vote of the membership at large.

It had been expected that the executive committee of the society would, after considering the matter, recommend final action to the meeting. The subject proved so amazingly intricate, however, according to rumors that filtered from the committee room, that no final action could be decided upon. The following resolution was therefore adopted and was reported to the meeting:

> It is the sense of the executive committee that the proposed change in the constitution of the American Engineering Standards Committee is not looked upon with favor at this time, and that a committee be appointed by the chair to confer with the other member bodies to get their views and report at the October meeting of the executive committee.

Inquiry made in the meeting as to the reasons for this action brought out the following explanation: The original scheme of organization as a committee (the reorganization would make this an independent association) has not yet been tried out, and it is thought desirable at this time to await actual experience with the committee plan. "Also," President Clamer stated, "the other societies have as yet not taken action in the matter." The announcement proved a distinct surprise, and despite the intense interest which the subject had aroused the technical program of the meeting was resumed before further discussion developed.

While no official statement was made, it is understood that any further action on the part of the society will not be taken merely by the executive committee but will be submitted to vote of the membership at large.

Intimately related to the problem of the standards committee was the presidential address, delivered by G. H. Clamer, the retiring president. "Standardization" was its subject. Sketching the parallelism of industrial advance with commercial standardization, such as the

harmonizing of candle and candlestick sizes and the adoption of a standard railway gage, the speaker developed the concept standardization in broadly ideal manner, to include the work of the War Industries Board conservation section—the arbitrary curtailment of styles and varieties of products—as well as the establishment of standard cost-keeping systems in manufacturing. Going then into the subject of international standardization, Mr. Clamer asserted that "nothing will promote international trade coöperation and good fellowship so much as would the establishment of wise and mutually satisfactory standards," some of which, he said, are an international language, an international religion, the metric system, the centigrade thermometer scale, an international coinage system, and the like. Finally, he expressed hearty approval of a central standardizing body, whether committee or association.

New Technical Coöperative Work

Several important joint technical committees are in process of formation, the executive committee announced. The decision to enter into such work on a large scale, as was demanded by various calls from the field, appears to have been delayed by the hope that the engineering standards committee would assume direction, according to its fundamental purpose; but the cessation of its work on account of the proposal to expand into an association made it necessary for the society to take the initiative.

Reinforced Concrete—Of widest interest, perhaps, is the case of the projected new joint committee on reinforced concrete. On the request of the society's committee C2 (reinforced concrete), the executive committee invited the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association to join with the society in forming such a joint committee. To confer and arrange for organization, a special committee has been appointed.

Rail—Coöperation with the American Railway Engineering Association on track steel has also been inaugurated, an undertaking that may produce results of very great importance. At present the work concerns only splice bars, bolts and tie-plates, but the executive committee has proposed that rails be included in the coöperative study. Revision of the rail specifications has been started by the appropriate committees of both societies, so that joining of the separate undertakings in coöperative work would be natural. There has hitherto been no effective harmonizing of conflicting views on desirable and commercially attainable standards of rail quality, but as the subject is being worked upon actively by the steel committee of this society, the rail committee of the steel manufacturers, and the rail committee of the American Railway Engineering Association, there is opportunity for bringing together all parties in interest.

Concrete Culvert Pipe—On invitation of the American Concrete Pipe Association, the society has joined with it and with the American Concrete Institute, the American Association of State Highway Officials, the American Railway Engineering Association and the American Society of Civil Engineers, in establishing a joint committee to consider specifications for concrete culvert pipe.

Aircraft Steels—Work on specifications for aircraft steels was started recently by the steel committee. To make the results more broadly representative, however, the Society of Automotive Engineers has been asked to coöperative in a joint committee.

Related purposes are involved in the appointment of a delegate by the society, at the Government's request, to take part in a conference of the International Aircraft Standards Commission. J. A. Mathews was appointed delegate.

Pattern Details—A request for the establishment of a committee to consider standardizing pattern colors, core prints, and the like, led to the decision to refer the subject to specialist bodies, such as the American Foundrymen's Association and the Pattern Makers' Association. The society will be prepared to coöperate on questions of materials if these bodies go forward with the subject.

Research Coöperation—Representatives of the society have been appointed, on invitation, to the engineering division of the National Research Council and to the American Welding Society.

Railway Mechanical Standards—Work initiated by the mechanical section of the American Railroad Association (this section comprises the men formerly constituting the Master Car Builders' and the American Railway Master Mechanics' associations) on standard designs and specifications for locomotive and other mechanical parts involves quality of materials. Preliminary consideration has been given to the possibility of the society's coöperating in this work, in order to make fruitful use of the methods its experience has developed in bringing together producer and consumer.

Besides these new joint activities, much coöperative work is already in progress. The coal committee, for example, works jointly with a committee of the American Chemical Society on subjects of sampling and analysis. The new specifications for steel plates for forge welding brought in at the present meeting were prepared in response to a demand from the chairman of the tank car committee of the Master Car Builders' Association, which committee, in its specifications, names the A. S. T. M. requirements for material as standard.

New Work on Specifications for Materials

Less active work in the field of specifications was done by the society's committees during this year than for a long time past, chiefly on account of the pressure of war work. In one of the most difficult subjects, however, in brass and other nonferrous metals, a remarkably large amount was accomplished, no less than six new specifications on bronzes and bearing metals being brought in.

Several new committees have begun work during the past few months, among them one on lime (reorganized), which has already reported a specification, and one on magnetic analysis, whose field was represented by an important series of papers read at the meeting.

It is not possible to review the specification work in detail here, but a list of the new, revised and reconsidered specifications is given below, followed by notes on one or two special phases of the work. The action taken by the meeting (which must be followed by letter ballot in the case of standard specifications) in all but two cases conformed to the recommendations of the technical committees. A proposed specification for adhesive insulating tape was not accepted and

was referred back to the committee. Proposed specifications for gypsum plasters were not accepted by the meeting, but were referred to the executive committee for decision as to the propriety of including working methods in a material specification.

NEW STANDARD SPECIFICATIONS
(Advanced from tentative standards)

Materials
- Malleable Castings
- Cartridge Brass
- Cartridge Brass Disks
- Naval Brass Rods for Structural Purposes

Test Methods
- Methods for Chemical Analysis of Manganese Bronze
- Methods for Chemical Analysis of Gun Metal
- Test for Flash Point of Volatile Paint Thinners
- Tests for Determination of Apparent Specific Gravity of Sand, Stone and Slag Screenings and Other Fine Non-Bituminous Highway Materials
- Method for Determination of Softening Point of Bituminous Materials Other Than Tar Products

Recommended Practice
- Recommended Practice for Laying Sewer Pipe

STANDARD SPECIFICATIONS AFFECTED BY REVISIONS

(Revisions are tentative, the standards remaining unchanged until subsequent action at a later meeting)

Materials
- Open-hearth Steel Girder and High Tee Rails
- Engine-bolt Iron
- 2½-in. Cotton Rubber-lined Fire Hose For Private Department Use
- 2½, 3 and 3½-in. Double-Jacketed Cotton Rubber-lined Hose for Public Fire Department Use

Test Methods
- Loss on Heating of Oil and Asphaltic Compounds

NEW TENTATIVE STANDARD SPECIFICATIONS

Materials
- Plates for Forge Welding
- Extra Refined Wrought Iron Bars
- Tinned Soft or Annealed Copper Wire for Rubber Insulation
- Brass Ingot Metal for Sand Castings
- Bronze Bearing Metal in Ingot Form
- Lead
- Solder Metal
- Building Brick
- Gypsum
- Calcined Gypsum
- Materials for Cement Grout Filler for Brick, Stone Block and Wood Block Pavement
- Materials for Cement Mortar Bed for Brick, Stone Block and Wood Block Pavement
- Block for Granite Block Pavement
- Rubber Hose for Use with Pneumatic Tools

Test Methods and Definitions
- Method for Battery Assay of Copper
- Method for Chemical Analysis of Pig Lead
- Methods for Chemical Analysis of Limestone, Lime and Hydrated Lime
- Test for Determination of Softening Point of Fire Clay Brick
- Definitions for Clay Refractories
- Methods of Test for Gypsum and Gypsum Products
- Test for Viscosity of Lubricants
- Methods for Determination of Fusibility of Coal Ash
- Method for Determination of Softening Point of Tar Products (cube-in-water method)

TENTATIVE STANDARDS AFFECTED BY REVISIONS

Materials
- Aluminum Ingots
- Aluminum Sheet
- Light Aluminum Casting Alloys
- Masons' Hydrated Lime
- Rubber Belting for Power Transmission

Test Methods and Definitions
- Test for Slagging Action of Refractory Materials
- Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys

Sulphur and Phosphorus in Steel

Peculiar interest centered in the action of the Steel committee on the war-emergency increase of the sulphur and phosphorus limits in steel, made last year. As stated by J. A. Capp, chairman of the committee, the effects of the war upon industry have not yet disappeared entirely, and some of the reasons for the higher chemical tolerances remain for the present. It was decided to restore the normal figures at once for those steels in which quality is most essentially affected by the change, and to retain the war clause in the other specifications until next year. This decision received the approval of the meeting.

The clause in question increased the rejection limits for sulphur in all steels and for phosphorus in acid steel by 0.01% above those fixed by the several specifications concerned, the increase to hold during the period of the war and until otherwise ordered by the society. The present action on this clause is summarized as follows:

ACTION ON SULPHUR AND PHOSPHORUS INCREASE IN A. S. T. M. STEEL SPECIFICATIONS

War Clause Removed 1919	War Clause Retained for Present
Bridge steel	Building steel
Structural nickel steel	Ship steel
Plates for stationary boilers[1]	Carbon steel rails[3]
Forgings and steel for forgings[2]	Tie plates
Splice bars, except low-carbon	Splice bars, low-carbon
Track bolts, except low-carbon	Track bolts, low-carbon
Wheels and tires (railway), all	Plates for locomotives and cars
Spring steels, all	Tubes for locomotive and stationary boilers
Tool steel	
Automobile steels	Chain
Girder and high tee rails[3]	Bars for concrete reinforcement
Screw stock	Castings

[1]Boiler and firebox steel for locomotives was not put under the war clause.
[2]In applying the war clause to car and tender axles no sulphur increase was allowed, the specification limit being high.
[3]No sulphur limit in specification; regular tee rails affected only as to phosphorus in acid open-hearth, but girder and high tee rails affected as to bessemer.

It is important to note that despite the increased chemical tolerances most steel products have been kept within the strict specification range; the clause, however, avoided rejections for occasional excess in check tests, and thereby proved a distinct convenience in the steel industry. Conditions are not altered in any radical manner by the present action, the tonnage of production being divided between the two classes so as to give ample outlet for steel that does not meet the check limits.

A Ball Test for Rails

Precedents in American rail specifications were broken by the Steel committee in abolishing the drop test for girder rails and high tee rails (for street-railway service), and replacing it by a ball-impression test for hardness. In view of the traditional position of drop testing for brittleness in the rail field, this action is revolutionary. It was taken at the request of electric-railway technical bodies, who desire a hard rail to resist wear and do not consider brittleness a danger where rails are bedded in pavements. Extension of this change in method to regular railway rails is not thought likely.

Further noteworthy features of the change are (1) that no upper limit of hardness is fixed, but merely a lower limit, to reject rail softer than desired, and (2) that the Brinell test is not adopted, a larger ball and a much higher loading being specified. A ¾-in. ball is to be placed on the head of the test rail and a load of 100,000 lb. applied for 15 sec.; the resulting impression should not be deeper than 3.6 mm. for class B or 3.8 mm. for class A rails.

Other Features of Committee Work

In the specification for tinned soft copper wire proposed as tentative standard there is included a new method for determining the integrity of the tin coating. It is based on the view that the tin coating must be entire, but should not be thicker than this object necessitates, as a thick coating will crack when the wire is bent or stranded and in any case reduces the conductivity of the wire. For these reason only two cycles of dipping in the test solutions are specified—the second cycle to make sure that spots which though not bare have too thin a coating are detected. The specified method is to dip a clean sample of the wire into dilute hydrochloric acid (sp.gr. 1.088) for 1 min., wash, wipe dry, and then dip for 30 sec. into sodium polysulphide solution (sp.gr. 1.142), which will blacken bare copper; then to repeat this cycle. If these two cycles

produce any blackening of the wire beyond ½ in. from the cut end, the sample is considered to have failed.

A flashpoint test worked out for paint thinners other than turpentine has, during the past year, been found to be accurate also for turpentine, and the Preservative Coatings committee therefore recommended its extension to cover all thinners. The same committee continued the inspection of test panels erected two years ago as a means of determining the best way of preparing iron and steel surfaces for painting. No conclusions will be reported before another year or two of exposure, but one well-defined result obtained so far is that cleaning a deeply rusted surface with scraper and wire brush is an unsatisfactory preparation for painting; the panels prepared in this way have failed badly. On the other hand, the plates which were painted as received from the mill, with mill scale intact and adherent, are among the best, up to date.

With the presentation of tentative specifications for viscosity tests of lubricants, a long contest in committee came to an end during the past year. The Saybolt instrument was decided on, in spite of the objection by various laboratory investigators that it does not give "absolute viscosity."

The method for determining the fusibility of coal ash presented by the committee on methods of sampling and analysis of coal is one which was formulated by A. C. Fieldner and has been used by the U. S. Bureau of Mines for several years. It was endorsed in joint action with the American Chemical Society.

A very simple colorimetric test for impurities in sand, for use in the field, was reported by the committee on concrete and concrete aggregates. It requires only a prescription bottle and some sodium hydroxide solution. For its application a color chart will be issued later.

Compression tests for cement have been under consideration by the cement committee. While no action has been taken, it was stated to be probable that a compression test will be recommended by next year, as a substitute for the long-standard tension test for cement.

Two important recommendations by the Lime committee involve broad interests. One took the form of a resolution asking that a standing committee on sand be appointed, to work with sand subcommittees of all technical committees whose field touches this important material. The other, expressed as a suggestion only, is that steps be taken by the society to endorse the standard sieves of the Bureau of Standards. In connection with this matter, joint committees on screens and on screen wire are under discussion.

Technical Papers on Tests and Materials

The meeting was noteworthy for the number of strong technical papers presented. As only four or five of those dealt with matters developed through war work, it appears that research in the field of testing and materials has continued in very active condition.

Progress made in rail study by the new method of attacking longitudinal sections of the rail head by hot acid was brought out by F. M. Waring and K. E. Hofammann, in a paper "Deep Etching of Rails and Forgings." Active discussion arose after the paper was read; the information developed in paper and discussion is summarized on another page of this issue.

Magnetic study of steel for uniformity and freedom from internal defects was made a special topic of the program, and five papers were read in which the results of the past half-dozen years' development of the subject were brought together. C. W. Burrows and F. P. Fahy, opening the series of papers, described the methods used and the results of some measurements, emphasizing the "very close relationship between the magnetic and the mechanical characteristics of steel." Other papers dealt with applications of magnetic methods to the discovery of defects in steel rails (P. H. Dudley), to the testing of ball-bearing races (R. L. Sanford and M. F. Fischer), and to the location of flaws in rifle-barrel steel (R. L. Sanford and W. B. Kouwenhoven), which showed that the promise of the method is still largely in the future. C. Nusbaum presented a study of magnetic curves of various steels and developed a method of "limiting values" by which, it is claimed, the mechanical properties can be determined from the magnetic properties.

New Testing Instruments

Five new instruments and machines for testing were described, distinctly extending the range of tests available for study of materials. Of related character was the American Concrete Institute paper of F. R. McMillan, describing the recording extensometer used in the ship-stress studies of the Emergency Fleet Corporation, which paper was read at a joint session of the Institute with the society. The "strainagraph," as this instrument is called, has been applied with remarkable success to both concrete and steel ships, and through its use a greatly increased fund of data for ship design is being accumulated. The vital importance of the subject precludes abstract of the paper here, but a full statement of results is likely to be available soon.

An extensometer of highly successful design, used in the laboratory of the Westinghouse Electric & Manufacturing Co., was described by T. D. Lynch and P. H. Brace, under the title "A Wire Testing Extensometer." It grips the wire by a spring clamp at one end of a pair of distance bars, and at the other end of the bars by two small rollers which carry axial mirrors on their ends. These mirrors reflect a beam of light from a small collimation-tube at one side of the instrument to a curved scale attached on the opposite side. Reading to 2/100,000 in. is possible. S. L. Goodale and R. M. Banks in a paper entitled "Development of Brinell Hardness Tests On Thin Brass Sheet," described a miniature Brinell machine for use in inspection of cartridge cases; the impression is made by a $\frac{1}{16}$-in. ball loaded with 15 kg. F. M. Farmer, in "A Fatigue Testing Machine," reported the design of a very compact repeated-stress machine for testing electrically welded ship plates under the auspices of the now-defunct Welding Committee of the Emergency Fleet Corporation. The testpiece is a rotating simple beam, loaded at the third-points, and the whole machine is only 5 x 19¼ in., though the specimen is 0.4 in. in diameter and 13 in. long. W. H. Herschel discussed the testing of light mineral oils in a paper on "A Viscosimeter for Gasoline"; with his new instrument, which has an outflow tube 24 diameters in length instead of 7, as in the Engler and Saybolt instruments, he has found that fluidity and density of gasolines are by no means proportional. An apparatus in which a slab of pitch is bent on a hinged plate while immersed in water whose temperature can be varied was described

by H. E. Lloyd and P. P. Sharples, under the title "Apparatus for Determination of Breaking Point of Pitches."

A new instrument for the paint field, the plastometer, which should be grouped with those just noted, was described in a paper referred to farther on.

Test Methods and Results

Fatigue and impact testing were dealt with in two papers. E. H. Dix, Jr., discussed impact-fracture tests using the Olsen, Izod and Charpy machines, and gave figures for a number of tests made for the Bureau of Aircraft Production ("The Single-Blow Notched-Bar Impact Test as Used in the American Industry"). Prof. H. F. Moore and A. G. Gehrig reported the results of a number of alternating-stress tests on nickel steels, tending to show that heat treatment does not improve their endurance ("Some Fatigue Tests of Nickel-Steel and Chrome-Nickel Steel"). They used logarithmic plotting of the results, thus continuing the application of the exponential formula which Prof. Moore has used as a working hypothesis of fatigue phenomena for some years past, but the results apparently did not add to the evidence supporting this formula.

Extensive corrosion tests of steel to determine the value of copper content were detailed by D. M. Buck ("The Influence of Very Low Percentages of Copper in Retarding the Corrosion of Steel"). His conclusion that as little as 0.03% copper reduces the rate of corrosion, and that 0.12% copper neutralizes the ordinary amount of sulphur in the steel, raised sharp discussion. A. S. Cushman argued pointedly against the author's views. A. F. Robinson said that both abnormal purity and copper content have little value, since they can at best be rust reducers, not preventives, and therefore a protective coating must be used on steel used for structures. When a coating is used, such observations as the author's are inapplicable.

A new concept was introduced into the paint field by a paper "Paint, a Plastic Material and Not a Viscous Liquid; the Measurement of Its Mobility and Yield Value," by E. C. Bingham and Henry Green. An instrument for measuring the consistency of paint, the plastometer, is described in this paper. The fundamental basis of the plasticity theory developed by the authors is that "a definite, appreciable force must be applied to a paint before it commences to flow. This force we have called the yield value." Active and laudatory discussion followed its presentation, in which all the leading paint men present participated. The consensus of opinion was that the new instrument and the authors' methods promise to extend the horizon of paint study considerably, and that the possibilities in this direction will be better known when many laboratories have an opportunity of making plastometer measurements.

Observations and Data on Materials

Research in materials was also represented prominently, various metals being dealt with as well as cement, concrete and refractory brick. The cement and concrete papers are grouped under a separate head, below. On the subject of refractory brick, C. E. Nesbit and M. L. Bell described the evils resulting from lack of uniformity in refractories. Their paper, "Preventable Defects in Refractory Bricks," elicited sharp, not to say acrimonious, criticism from representatives of refractories manufacturers present at the meeting. The author's statements and arguments were well supported, however, by J. S. Unger and by G. C. Stone, representing large users of firebrick. Dealing with "Steam Hose for Car Heating," H. J. Force described a method of manufacture which has been found to reduce hose failures by contraction in length or expansion in diameter. He recommended three-ply calendered tubing for hose subjected to any considerable temperature.

"Modern High Speed Steel" was covered by John A. Mathews, historically and by the presentation of extensive test data for present-day high-speed steel, which he defines as a vanadium-containing tungsten-chrome steel. Discussing the paper, several tool-steel men argued for the value of cobalt additions, which the author had deprecated as lacking any demonstrated good effect. A valuable compendium of data on American malleable iron was given by H. A. Schwartz, under the title "Some Physical Constants of Malleable Cast Iron." Marked improvement in the quality of aluminum casting alloys by heat treatment (quenching) was reported by P. D. Merica and C. P. Karr, in a paper "Some Tests of Light Aluminum Casting Alloys."

A new chapter was added to the history of season-cracking of bronze and brass by a paper of P. D. Merica and R. W. Woodward, "The Behavior of Wrought Manganese Bronze Exposed to Corrosion While Under Tensile Stress." Test pieces of annealed bronze were placed in series with steel test bars in frames by which the bars could be strained in tension, and in this condition were exposed to corrosion by water and moist air for about two years. No specimen which was stressed below its proportional limit broke, and four specimens strained sufficiently to undergo a slight permanent set did not break. Generally specimens whose stress was below 35,000 lb. per sq.in. remained whole, while those stressed to more than 40,000 lb. per sq.in. broke. Specimens protected from corrosion did not break.

Cement and Concrete Papers

Proportioning concrete came in for a major part of the discussion in the concrete session. As a basis there were two papers, on "Proportioning of Pit-Run Gravel for Concrete," by R. W. Crum, and on "Theoretical Studies in Proportioning Concrete by the Method of Surface Areas," by R. B. Young. Mr. Crum's tests were made to determine a working basis for Iowa aggregate as used in highway work in that state. The method consists essentially in controlling the aggregate by the proportion of fine to coarse aggregate. The paper is abstracted on another page. Mr. Young reported the preliminary work of the Hydroelectric Commission of Ontario, which is placing many thousand yards of concrete. The tests are at present very extensive and tend to prove the applicability of the surface-area method for practical work. The author contends, however, that the fineness-modulus method is only another means of determining the physical condition which surface area represents. In the discussion Professor Abrams disagreed to the extent of claiming that the surface-area method does not check the fineness-modulus method except when the material is uniformly graded.

G. M. Williams, of the Bureau of Standards, stated that, so far as their tests go, they were unable to check the fineness-modulus results with those by the surface-area method. He also stated that neither one appears

to insure concrete of known or uniform consistency, and therefore is not usable in laboratory comparison. Prof. A. N. Talbot stated that the laboratory of the University of Illinois had been making a number of tests in an investigation of this matter, both with the surface-area and with the fineness-modulus methods. He said that these tests tended to show that strengths were dependent upon surface areas and that while both methods apparently have possibilities, at present he favored a surface-modulus method which gives a relation to the surface area. In concluding, Professor Talbot said that a number of elements enter into the manufacture of concrete and that we cannot take any single one and say that it represents the distinguishing element in the properties of the material. L. N. Edwards, the propounder of the surface-area theory, also discussed the papers.

Another paper on concrete was a very extensive one on the modulus of elasticity of concrete by Stanton Walker. This gives the results of thousands of tests and establishes the relation between four different measures of the modulus of elasticity of concrete in more or less common use. A paper on methods of curing standard concrete specimens, by Howard W. Green, checks previous conclusions on this subject.

Cement fineness has been made the subject of an extensive series of tests at the Structural Materials Laboratory of Lewis Institute during the past year. The results of the tests, covering many pages, were reported in a paper by Prof. Duff A. Abrams. Briefly, he experimented with seven different degrees of fineness varying from 2% residue on a 200-mesh sieve, to 43%, and broke in compression some 6000 6 x 12-in. cylinders, and in tension some 9,000 mortar specimens. He found that fineness increased strength in a straight-line ratio, the increase being about 2% (seven days' strength) for each 1% additional fineness up to about 91% through a 200-mesh sieve, after which the results are erratic. He found, however, that the additional strength gained by a 1% additional fineness was about the same as that gained by a 1% increase of cement.

Marburg Memorial Meeting

Impressive tribute to the memory of Edgar Marburg, secretary of the society since its foundation, was rendered in addresses delivered at a ceremonial session held on the evening of June 24. President G. H. Clamer, expressing for the officers of the society their feeling of loss, dwelt on Professor Marburg's position of leadership in the executive committee and on the direction given to the society's affairs by virtue of his personal strength. John M. Goodell reviewed Professor Marburg's career as an engineer. Robert W. Lesley, dealing with the early years of the society, and Arthur N. Talbot, on the later years, set forth in fuller detail than had been done by President Clamer the service which the society received from its late secretary. In closure, Robert W. Hunt paid warm personal tribute to the departed.

A notable function, also, was the conferring of honorary membership in the society upon three men of countrywide fame, Henry M. Howe, Robert W. Hunt, and Mansfield Merriman. All three have been active as leaders in testing circles since the earliest days of the society. They are the first to be so distinguished by the Executive Committee.

The following are the newly elected officers of the society: President, J. A. Capp; Vice-President, C. D. Young; Members of the Executive Committee, Ernest Ashton, H. F. Moore, C. F. W. Rys, and Admiral D. W. Taylor.

Very favorable conditions of finances and membership were reported. The society has grown to a membership of 2481, a net gain of 220 during the year. Its income was so carefully managed that in spite of increased expenses and undiminished activity in publication a surplus of $2300 resulted. Corresponding to the growth of the society, the present meeting was by far the largest in attendance in its history, with a registration of 762 members, which is 179 more than present at any prior meeting.

Further Data on Effect of Copper in Reducing Corrosion of Steel

BY AN elaborate experimental research into the speed of rusting of steel containing very small amounts of copper, D. M. Buck has determined that the principal protective effect is exerted by proportions of copper so small that most analysts would report them only as traces. The results are made public in a paper read before the American Society for Testing Materials. Increasing the copper content from 0.01% to 0.03% decreases the corrosion by 30 to 40%. With a normal sulphur content of about 0.05%, a copper content of 0.12% gave virtually as complete protection as larger amounts. A copper percentage of 0.15% is considered sufficient to protect steel even with considerable excess of sulphur.

Previous experimentation had indicated that the protective influence of copper is noticeable at much lower copper content than had previously received consideration. To explore this phase of the matter further, new tests were undertaken. Actual atmospheric exposure was used for the purpose of the tests. By making various copper additions to different pourings of an open-hearth heat, copper contents of 0.012 to 0.254% were realized in the resulting ingots. Corrugated sheets, generally of No. 26 gage, were made from these. These sheets, 26 x 96 in., unprotected by paint or other coating, were placed out in the open on inclined racks in the Connellsville coke region, two years ago. A number of 2 x 4-in. test pieces from the same sheet exposed at the same time and place were used for test weighings.

The curve of loss of weight per square foot per month dropped sharply from about 0.50 oz. for low copper steel (about 0.01%) to a value of about 0.15 at a copper content of 0.05%, and then remained almost constant at this value. This is true of a steel of high purity (sulphur content, 0.03%). Higher sulphur changes the result. Not only does it multiply the initial rate of corrosion loss (for low-copper steel) making this value about 1.5 oz. per square foot per month, but also increases the copper percentage at which the full protective effect is attained. With steel containing 0.055% sulphur, the corrosion curve did not reach an approximate horizontal until 0.12% copper was reached.

In addition to the direct conclusions already indicated, concerning the amount of copper needed for protecting steel from rapid corrosion, the author concludes from his work that, since in previous research it has been customary to consider a copper content below 0.05% as a trace, it may be desirable to reinterpret many of the earlier corrosion data.

Further Data and Views on Rail Fissures and Quality

Results of Deep Etching—"Cracks" Found in Rails, Tires and Steel Wheels—Discussion at Testing Materials Meeting

Carrying farther their studies of "cracks" in rails revealed by etching with hot acid, discovery of which they announced to the American Railway Engineering Association three months ago in a memorandum to the report of the Rail committee (see *Engineering News-Record*, March 27, 1919, p. 610), F. M. Waring and K. E. Hofammann of the Pennsylvania R.R. told of new discoveries in a paper "Deep Etching of Rails and Forgings," read before the American Society for Testing Materials last week. Important contributions to the ubject were made in the discussion of the paper.

The remarkable gashes developed by deep etching of longitudinal slabs from the rail head have so far been found in all transverse-fissure rails, and in numerous unbroken rails of heats that had produced transverse-fissure rails. Whenever such an unbroken rail showed transverse fissures when broken under the drop, its metal showed characteristic gashes upon etching. So far, no "cracks" have been found in rails that did not exhibit transverse fissures.

Next, it was found that some new rails develop gashes in deep etching. This made it appear that service in the track does not originate the defects of the gashes though it may be the agency that produces transverse fissures in such defective steel. It was therefore suspected that steel used for other products than rail might show similarly defective quality. Slabs from locomotive tires and from rolled steel wheels were etched, and gashes were developed similar to those shown by rails. A tire that broke after running only 25 miles developed numerous transverse "cracks" on both tangential and radial longitudinal sections.

Microscopical and chemical examinations have not yet shown the existence of any inclusions in the "cracks," nor any abnormality of microstructure near these points. The "cracks" extend through the grains of the steel as well as follow the grain boundaries. The authors' concluding passage is important:

> The manner in which the acid attacks these defects and rounds off the edges leads us to speak of them as cracks, but so far the investigation has not developed the cause. We are inclined to believe that the cause must be sought in the mill during some stage in the process of fabrication of the material.

A supplementary observation on the effect of annealing was reported: Companion slabs were cut from steel suspected of defects, and one was etched directly while the other was first thoroughly annealed. The second piece exhibited about the same degree of gash formation upon etching as did the other.

Opening the discussion of the paper, J. A. Capp advanced a theory which the annealing test tended to overthrow. It is that hydrogen liberated in the interior of the metal as the acid penetrates porous spots develops enough pressure to crack the metal where large initial strains exist. According to this theory, formulated on the basis of prior observations on steel springs, annealing should prevent the cracking.

J. E. Howard expressed the view that the evidence at hand tends to show the "cracks" to exist before etching. Certain appearances of the fracture faces suggest to him that these cracks are formed at a fairly high temperature. The orientation of the longitudinal cracks points to transverse strains as responsible.

By turning the discussion on the "snowflakes" found in ordnance steels, Col. W. P. Barba suggested the similarity or identity of these flakes, the "gray spot" defects which according to M. H. Wickhorst are always associated with transverse fissures, and the gashes produced by deep etching. He stated that X-ray investigations by H. S. Rawdon have revealed flakes in unbroken metal. Good ingot practice, Col. Barba claimed, prevents flake defects.

J. S. Unger demanded whether criticisms of manufacturing methods are justified so long as the injuriousness of the gash "defects" remains unproven. The formation of the gashes may be only a manifestation of different solubilities of the steel in different directions; he has found rail steel to be four times as soluble longitudinally as transversely or vertically, and concludes that local sponginess may be greatly exaggerated by acid.

M. H. Wickhorst expressed the view that the cause of the gash defects is not yet known. Remarkable results have been found recently in an elaborate study of a heat of fissure rails. Close correlation of transverse fissures and "gray spots," which may occur either with fissures or separately, was established. The fissure rails revealed a badly shattered condition of the head metal upon etching, while the rails with simple gray spots were in less shattered condition. The cracks appeared to serve as nuclei for the development of transverse fissures. Confirming previous results, no chemical peculiarity could be detected in the defective metal.

A theory as to the cause of fissuring was proposed by H. J. Force, namely that it is due to not holding the steel in the ladle a sufficient length of time. Where the steel is held 9 or 10 mins. better rail is produced, he stated, and he knows of no bad rails produced from ingots teemed after holding the ladle this length of time, while some defective rails were found to have been poured after only 1½ min. in the ladle. That fissuring is chargeable to steel condition is supported by the experience of 12 years' work, in which it has been found that a certain lot of rails from a certain mill will tend to develop transverse fissures while another lot will not, though in the same service.

It is not possible to make good steel from bad ingots, said Guillaem Aertsen, though bad steel can be made from good ingots. The transverse cracks in tires, however, suggest an analogy with the formation of fishtail ends on bars in rolling: if such a bar be thought of as joined into a ring it will be seen that there would be a shortage of metal on the middle line, tending to produce cavities. It is known that rolling can develop cavities in sound steel.

C. B. Bronson reported the conclusion from tests that forging can suppress or remedy cracks in rail steel, while annealing 4½ hr. at 1000° C. does not reduce the extent of crack development. An attempt was made to locate and bring out the cracks in rail steel magnetically, so as not to destroy any of the material by etching. The steel was magnetized and iron filings were dusted over it. Only partial success was attained in locating cracks. The New York Central work on the subject has led to the inference that the "cracks" in rail steel are produced by the rupture of zones of hot-short metal in the rolling process.

Quick-Hardening Concrete With Special Cements

A PAPER entitled "Cement Producing Quick-Hardening Concrete," giving results of certain tests with Sorel cement, a commercial product, and with certain calcium aluminate cements made in the laboratory of the United States Bureau of Standards, was presented by P. H. Bates, of the bureau, before the American Society for Testing Materials. Concretes made from these cements reach a high strength at an early period. For instance, some of the calcium-aluminate specimens in a 1:6 gravel concrete had a strength of 3145 lb. per square inch at the end of 24 hours, 6010 lb. per square inch at the end of seven days, and 8220 lb. per square inch at the end of one year. The Sorel cement is a light calcined magnesite gaged with magnesium chloride. In ordinary commercial mixtures, concrete made with it reached in 24 hours approximately the same strength as the ordinary portland cement concretes do in seven days. In the author's opinion, a further study of these quick-hardening cements should be made because there appear to be a number of places where they could be advantageously used. It appears, for instance, that the Germans used such cements extensively in the construction of field fortifications. On account of their relative lightness compared with portland cement, there has to be care in their proportioning, and concretes made from neither of them would be desirable where they would be subjected to the continued action of water.

Tests of Concrete Tanks for Oil Storage

IN A paper with the above title, read before the American Concrete Institute, J. C. Pearson and G. A. Smith describe the results of a series of tests made by the Bureau of Standards for the concrete-ship section of the Emergency Fleet Corporation to determine the effectiveness of concrete as a retainer of oil. Tests were made with various oils in small containers of concrete of the usual 1:2:4 mix and of the richer 1:$\frac{3}{4}$:$\frac{1}{2}$ mix of the concrete ships, the latter being tested also under a 25-ft. head. The results are summarized by the authors as follows:

1. Various mineral oils, covering practically the entire range of fuel oils, have been stored in concrete tanks approximately 13 months, apparently without injuring the concrete in the slightest degree.

2. Concrete test cylinders, 6 x 12 in., have been stored in these oils during the same period and have shown no appreciable diminution in compressive strength.

3. A number of vegetable and animal oils have been stored successfully in concrete tanks for a period of 13 months, and only two, cocoanut oil and lard oil, have appreciably attacked the concrete.

4. Quantitative losses of fuel oils have been determined in 1:$\frac{3}{4}$: concrete tanks under pressures of 12 to 15 in. of the oils, and in a smaller number of tanks, under a pressure head of 25 ft. These measurements indicate that even under the latter conditions heavy and medium-weight fuel oils can be stored in concrete of this character without excessive losses. The storage of kerosenes and gasolines under these conditions will probably prove uneconomical, unless some impervious coating can be found which will be durable under long exposure to the lighter oils.

5. In a single test of six months' duration, spar varnish has apparently been effective in successfully retaining a 43° kerosene of 0.015 viscosity. The loss during this period has been practically negligible.

Effect of Vibration, Pressure and Jigging on Concrete

TESTS to determine the effect of vibration and pressure on fresh concrete were made in the Structural Materials Research Laboratory in Chicago last year and were reported in a paper by D. A. Abrams read befor the American Concrete Institute. The experiments simulated in the laboratory various systems of agitating the concrete during placing which have been tried out in recent years. They included the vibrating of a small form with an electric hammer such as was used in the concrete-ship work, the jigging of fresh concrete on a special table, a process used in the manufacture of certain concrete products, and the application of pressure on small concrete specimens. All the tests were of 28-day 6 x 12-in. concrete cylinders.

Professor Abrams says: "The tests show that after the concrete is properly placed these methods of treatment do no good and may be harmful if too severe or too long continued. However, there can be no doubt of the value of such methods for getting concrete into place in intricate forms and around reinforcing bars. The tests are of value in showing that this is the only desirable function of such treatment. With jigging high strength may be secured with drier mixes than would be feasible otherwise. Concrete of drier consistency (and consequently higher strength) can be placed by means of jigging or vibration than would be possible by usual methods."

General conclusions are as follows: Varying the number of strokes from 12 to 50 on each 4-in layer in hand puddling with a $\frac{3}{4}$-in. bar has little influence on the compressive strength of ordinary plastic concrete. In general, tamping methods give lower strength than hand puddling. A tamper of large diameter for a given weight is less effective than one of small diameter, and increasing the thickness of a layer from 4 to 6 in. causes a falling off in strength of about 12% for tamped concrete. The standard method of hand puddling, using 25 strokes and a $\frac{3}{4}$-in. steel bar for each 4-in. layer of concrete, and the use of a 6 x 12-in. cylinder, are recommended for laboratory tests.

Vibration of the specimen after molding, by means of an electric hammer running at 1000 r.p.m., has little influence on the strength of puddled concrete up to a period of about 30 sec. If the vibration is continued, there is a steady falling off of strength. Jigging reduces the compressive strength of the concrete regardless of the height of drop, the rate or duration of treatment. Exceptions are found in dry mixtures and those made of aggregate of smaller sizes. In very dry mixtures, strength due to jigging for 20 sec. is increased about 25%, and concrete of finer aggregates showed a material increase in strength with jigging above 1:5 and 1:3 mixtures. The faster the rate of jigging, the lower the strength of 1:5 concrete. Allowing concrete to stand for a period of time before jigging increases the strength to a slight extent, the maximum increase being found at from two to four hours.

Compressive strength of the concrete is increased by pressure applied immediately after molding. With compressions of 200 to 500 lb. per square inch, the increase is 20 to 35%, but the duration of pressure between 15 min. and 16 hours produces no difference in strength. Strength is increased because the water is expelled.

How Will Congress Determine the Future of Our Railways?

Most Important Economic Question Before Country —Quick Action Providing Return of Roads and Guarantees Required

By L. C. Fritch
M. Am. Soc. C. E., Past President, American Railway Engineering Association

WHAT legislation will Congress enact to safeguard our transportation systems?

This is the most important economic question confronting the country and has a greater bearing upon the future prosperity of the country than the peace treaty itself, notwithstanding the fact that the president dismissed the subject with only a single sentence in his message to Congress and referred the responsibility to the legislative branch of the Government.

Government operation has proved an expensive experiment and will cost the country upward of two billions of dollars before the books are closed and accounts settled. It has, however, demonstrated and settled these facts—the inefficiency of the Government operation and the doom of Government ownership of public utilities. It may cost a huge sum to prove the fact, but it is worth the price, and has cost much less than if the Government had actually acquired ownership of the railways and then failed. The public will be satisfied to pay the score, if only Congress will atone for the mistake of the past and enact such legislation as will restore the railrays to their owners and protect them in such a manner that they may not only survive but expand and serve the country in its future growth.

We are on the eve of the greatest boom this country has ever experienced. In a short time the temporary unrest in Europe will give place to rehabilitation and reconstruction of the countries devastated by the war, and the United States will be called upon to supply the necessary raw and manufactured materials to meet the enormous demand. We shall have one of the largest crops this autumn the country has ever enjoyed. All these things need transportation, above all else.

Sufficient Transportation Facilities Lacking

The transportation industry has been at a standstill for the past two years, and in no single item has there been the necessary expansion of facilities to meet even the normal demands. The Railroad Administration is standing absolutely still and making no program whatever to meet the transportation growth which this country will need before the current year is closed.

There will not be sufficient locomotives and equipment and sufficient terminal capacity to handle even the enormous wheat crop which is even now maturing and will begin to move in a few weeks. Congress should wake up and realize the true situation which confronts it, and act promptly and intelligently upon this important matter.

The President has announced that the roads would be returned to their owners on Jan. 1, 1920, but Congress will decree that they shall not be returned to their owners until the necessary legislation has been passed to save them from bankruptcy and provide the necessary means that they may fulfill their public function. It would be suicidal to do less than this, and Congress, as now consituted, is fully aware of this salient fact.

Whatever legislation Congress will enact to meet the situation, there are certain fundamentals which cannot be ignored and which must be squarely met, or this important question will not be settled.

First—There must be, in some form or other, a sufficient revenue derived from transportation operations to meet the necessary expenses, give a return on investment, and provide surplus for future growth to meet the country's need. Whether this is in the nature of a scale of rates or a guarantee by the Government, matters not so much as the fact that it must be provided. Unless this is done, it would be as well to dodge the whole question and turn to Government ownership, since a failure to give adequate return means bankruptcy and disaster to the country's progress and welfare.

The Government can well afford to give a substantial guarantee to capital invested in railways, until such time as a level of rates can be established that will provide the necessary revenues, but it will be the same old story over again if Congress merely states that "rates shall be such as to provide a reasonable return on capital invested, etc." This has never yet been demonstrated, and never will, until Congress gives to a commission the necessary authority over rates and their establishment as well as over wages and the expenses of the railways. Then, and not until then, will it be safe to float the ship on a "level of rates." The Government should continue the "standard return" of the "test period" until this "level of rates" has been firmly established.

Legalized Consolidation into Large Systems

Second—There must be legalized consolidation of lines now prohibited, in order that the weaker lines may be absorbed by the stronger lines. No satisfactory rate structure can be established under present conditions, for the reason that rates that would give adequate revenue to the strong lines would not be sufficient for the weaker lines and, conversely, rates sufficient for the weak lines would produce inordinate revenues for the stronger lines. There must, therefore, be a consolidation of the strong and weaker lines to remove this difficulty.

The country should be divided up into about eight traffic regions, and in each region there should be not less than two competing railway systems, composed of the strongest lines in the respective regions as a nucleus, and the weaker lines allocated to these systems. The Warfield plan does not agree that this is possible. The answer is that it is far better for the strong lines to acquire the weaker lines on an equitable basis than for all the lines to go into bankruptcy or into Government ownership. If it had not been for the Sherman law, and if E. H. Harriman had lived, the railways of the country would now be consolidated into a number of strong systems. Harriman saw this necessity twenty-five years ago and was working toward this end in his combinations.

Third—There must be a stronger Governmental regulating body to supervise the operations of the carriers, regulate rates, be responsible for both the revenue and expenses and deal justly between the owners and

the public. The Interstate Commerce Commission—reconstituted, enlarged and given ample powers—is the proper Governmental agency to supervise the railways.

The present interstate commerce law, and not the commission, is responsible for the present condition of the transportation industry. Change the law and give the commission power and jurisdiction, and hold them responsible for the results. The commission should have in its organization, in addition to some of its present able members, real railway men, and not be entirely composed of lawyers and politicians. Place some able operating and traffic men on the commission. Futhermore, there should be in each of the eight regions a subcommission reporting to the central commission in Washington. These regional commissions would be in close touch with the public and the various state commissions.

The commission should also be given jurisdiction over operating matters such as service and the necessary expenditures for proper maintenance of the properties.

The commission, reconstituted and empowered by law to see that the revenues of the carriers are sufficient to meet expenses, fixed charges and a surplus to meet the needs of expansion, will properly fulfill its functions and will go a long way toward solving the railway problem.

The financial need of the railways will amount to one and one-half billions per year for the next five years or about seven or eight billions in that time. No capital will be available to meet this demand unless a proper solution is found that will give a fair return on the capital invested.

VALUATIONS MUST BE QUICHLY CONCLUDED

Fourth—There must be a strong commission appointed at once that will reach a prompt conclusion on the value of the carriers on which a return shall be allowed. As a matter of fact this is one factor of the problem that must be known before there can be established the level of rates, that will determine the reasonableness of the rates.

Sufficient evidence is already available, from the Government valuation work, which, if intelligently applied, will enable a commission to arrive at a value of each carrier's property that will not vary materially from the figures that will be ultimately arrived at by the valuation department of the Government. There must be action now, and the country cannot await the results of the present valuation commission, which will not reach a final conclusion for ten years.

Fifth—There must be founded a strong financial commission that will aid in financing the needs of the railways until such time as the roads can finance themselves or until their credit is restored and capital will seek railway investments instead of railway needs seeking capital. This commission should also pass upon all financing by the carriers on present and future financial plans, and no issue of securities should be permitted without the approval of this finance commission. The moral effect of this plan would at once give the public confidence in railway securities and have a most wholesome effect upon the financial situation and credit.

Congress is fully equipped with information on all phases of the railway problems, and can by its action resolve the situation into one or the other direction. First, pass the suggested remedial legislation and enable the railways to live by their own efforts. Failure to pass such legislation or only partially to relieve the situation will result in a wrecking of the transportation industry, a financial panic of widespread dimensions, and ultimate Government ownership, with all its attendant evils.

Cost of Pumping is Reduced 30 Per Cent. by Test

AN INVESTIGATION of the cost of pumping by air lift from well to cistern, and by power pump for distribution, at Grinnell, Iowa, gave 15.527c. per 1000 gal., as compared with 22 to 24c. based on an earlier test. This case was described at the annual meeting of the Iowa Section of the American Water-Works Association by W. G. Raymond, dean of the College of Engineering at the Iowa State University. The measurements in the test were made by Prof George J. Keller, acting head of the department of mechanical engineering.

When one of the two wells got out of repair early in 1918 the deep-well pump in the other well could not supply the demand, and the former air-lift system was resumed. This proved successful, but the Iowa Light, Heat & Power Co. which had the contract for pumping, claimed that the cost was increased greatly, and the city agreed to pay the actual cost until a new well was put in service. This was billed monthly at 22 to 24c. per 1000 gal., but the city complained that this was too high, and the company appealed to the Iowa State Board of Conciliation. Both sides were inclined to be fair, but the city had little to disprove the company's claims. The board recommended a cost of 22c., but acknowledged that this appeared to be very high, and informally recommended that the city make an investigation. Dean Raymond was then engaged to determine the actual cost.

As the rate was to be temporary, pending the use of the new well, it was considered inadvisable to make a complete valuation. The company's statement of the costs of the plant and equipment was used for estimating interest and depreciation charges, and the books were examined to determine cost of labor, fuel and supplies. Readings of the meter through which water was obtained for steam making were taken as indicating the quantity of steam produced, it being concidered that these readings, extending over a year, would be of more value than the results of a single, costly test. To determine the power used in lifting the water, measurements were made of the steam flow to the compressor and the water delivered to the cistern during the same period. This showed 249 lb. of steam per 1000 gal. of water raised.

The total cost of pumping was found to be 15.227c. per 1000 gal., distributed as follows: Steam for air-pumping, 11.398c.; power for power pumping, 1.369c.; labor, supplies, interest and depreciation, 2.76c.; total, 15.527c. Deducting 0.3c. for depreciated plant leaves 15.227c. Settlement by the city was made on this basis.

Shipbuilding Equipment and Methods at Fore River—I. Hull Construction Plant

Single Type of Berth for Various Kinds of Ships—Concrete Substructure and Bridge Crane Equipment—New Battleship Berth—Two-Bay Fabricating Shop

DURING 1918 the Fore River yard of the Bethlehem Shipbuilding Corporation, Ltd., made a remarkable shipbuilding performance. It delivered to the Government 17 destroyers, 10 submarines, and six merchant ships, the latter totaling 61,000 tons' carrying capacity; more destroyers were turned out by Fore River than by any other yard in the country. A working force of nearly 20,000 was employed, which is double the normal complement and four times the force employed at the beginning of 1917. Early in 1918, in fact, the number of men on the rolls amounted to 26,000. This included the skeleton of a complete organization for the new Squantum destroyer plant, five miles away, a plant designed and built by the Bethlehem company at the request of the Navy Department and operated since April, 1918, by Fore River.

In this intensive production, the physical equipment of the yard made an excellent showing. It proved capable of good service even with the phenomenally increased working force, though, it is true, with noticeable crowding in the shop as well as on the berths and in the storage yard. Expansion and modernization of the Fore River plant had been carried out just before the high-pressure shipbuilding of the war period began, and the enlarged plant, including new shops and additional shipways, and methods of operation which were devised to suit the new conditions as the old proved inadequate, made it possible to maintain efficient production throughout. Particularly interesting, as regards hull construction, is the fact that the high-pressure work evidenced the satisfactory performance of a single type of berth for all the types of ships in the yard.

Expansion of the yard had been started in 1915. New berths for building submarines, a steel fabricating shop of 250 tons' capacity per day, a battleship-building slip, and new turbine and mechanical shops, were items of the program. The new hull-steel fabricating shop, built in 1916, gave a sound basis for the development of efficiency and high capacity in the hull-construction end of the yard. A new galvanizing shop for destroyer frames and plating was also completed in 1916, followed in 1917 by the new steam-turbine shop and the battleship slip. When the urgent war demand came, early in 1917, four temporary building berths for destroyers were added, these requiring only a few months to build and equip.

As now developed, the plant is shown in the ground plan, Fig. 2, which gives the layout of slips and buildings, but does not show an outside area, for storing both raw and fabricated hull material, at present under development. About 10,000 men constitute a normal working shift, and with the present force the plant is working under overload conditions in most of the departments.

All the permanent building berths at Fore River are of the same type, whether intended for submarine and destroyer construction or for building battleships or large merchantmen. The way foundation is of concrete, and overhead bridge cranes spanning the berth are provided for handling the ship material.

Typical of the Fore River berth construction is the newest and largest berth (A in the plan, Fig. 1), designed to take the largest battleships, cruisers and merchant vessels. It is 805 ft. long and 131½ ft. wide between inner columns of the crane runway. Its main portion is a longitudinal keel-block slab 38 ft. wide, with a level top stepped up 9 in. at intervals of 24 ft. (launching slope ⅜ in. per foot). Concrete sills 2 ft. wide extend out laterally from this backbone as shown, to a maximum distance of 30 ft.; these sills, spaced 16 ft. apart, are for the support of shores under the ship's bottom. Rock and firm soil were found at the site for the most part, so that little preparation of the ground was required. Outboard of the concrete foundation the launching ways are carried on timber pile bents, as is customary. The backbone slab of the berth is channeled longitudinally on either side of the middle 13-ft. widtl

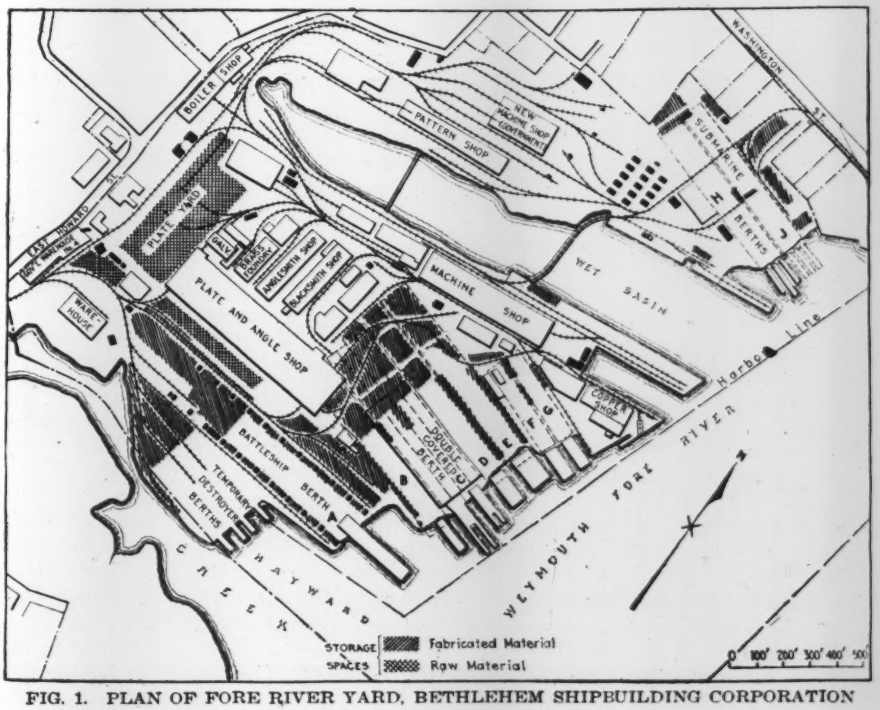


FIG. 1. PLAN OF FORE RIVER YARD, BETHLEHEM SHIPBUILDING CORPORATION

to carry off drainage from the tanks at the time of testing.

Steel towers to either side carry the crane runways. This particular berth has unusually ample crane equipment. There are two superimposed runways, the lower carrying one 50-ton crane, and the upper runway three 7½-ton cranes.

Different varieties from this berth construction appear in the other slips. Usually their substructures are simple, narrow, concrete slabs, and they are covered by a single runway with either one or two cranes of about 10 tons' capacity. They are represented in a general way in the series of cross-sections, Fig. 4. The four groups of berths north of the battleship slip, numbered 9, 8-7, 6 and 5, can be used for building vessels up to battleship size.

In respect to superstructure and crane arrangement, an interesting exception is the double berth 7-8, which was the first bridge-crane berth built at Fore River. It was constructed 18 years ago, when contracts were taken to build the battleships Rhode Island and New Jersey. The building berth itself was roofed over in 1915 and has a clear width of 184½ ft., sufficient for building two ships of large size under the roof. Inboard of the bow of the ship, however, the roof is discontinued, and the transverse trusses rest on a line of central supports. The crane runway girders are suspended from the roof trusses; there are four runways, each containing one five-ton crane, spanning about 44½ feet.

The two northerly slips of the yard are each a triple berth (three lines of ways under each craneway), but on each line of ways three submarines are built in tandem, so that the two slips accommodate 18 hulls. One of these slips has two cranes, the other only one. This latter proved to be rather short in crane capacity for maximum production, the officials of the yard state, but elsewhere throughout the plant the bridge-crane service has been ample for all needs, even under the greatest pressure for speed.

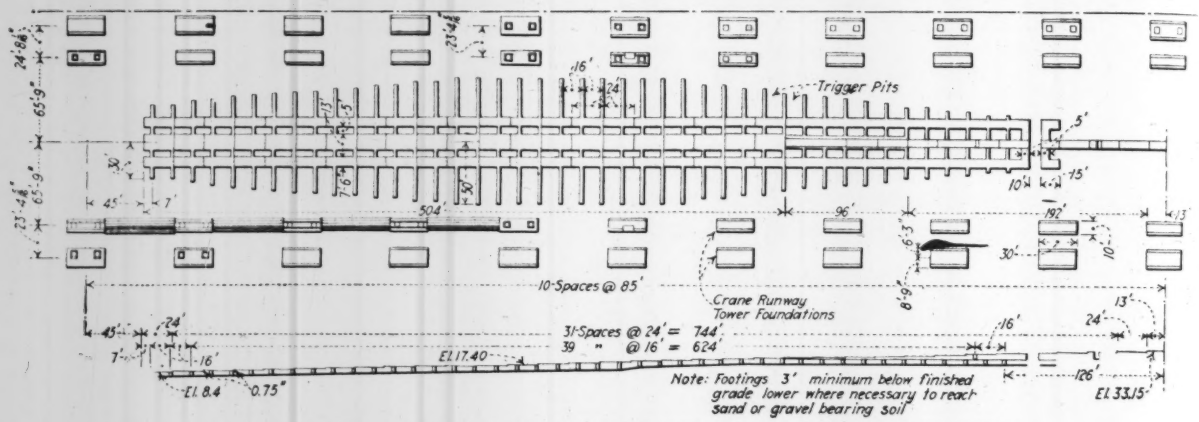


FIG. 2. CONCRETE SUBSTRUCTURE OF NEW BATTLESHIP BERTH AT FORE RIVER

Four temporary destroyer ways built at the southern end of the yard a year ago lack bridge-crane equipment and are served by locomotive cranes. These travel on two high trestles between the outer and inner berths. Two cranes work on each trestle. None of the berths has tracks or roadways leading down along the ship. The plant is designed and operated solely for supply from the shops to storage spaces at the head of the berths, and for handling longitudinally from this space to the ship under construction, by means of the overhead cranes.

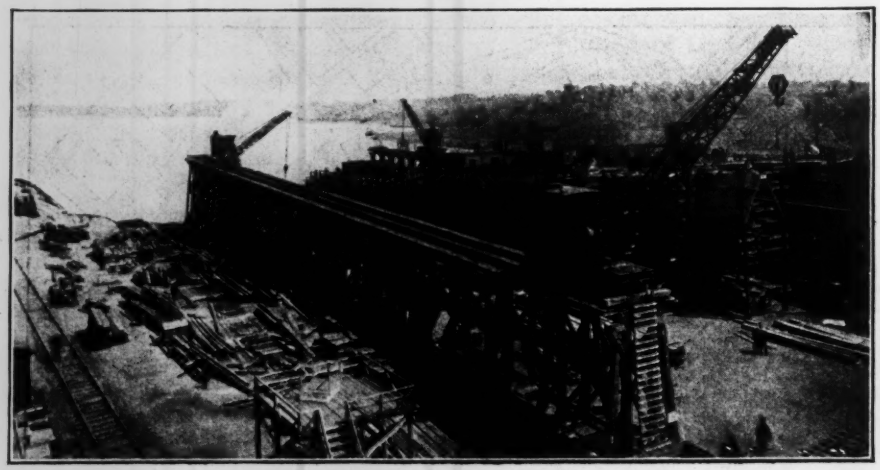


FIG. 3. DOUBLE CRANE RUNWAY OF BATTLESHIP BERTH

Located as indicated on the plan, Fig. 1, the steel-fabricating shop stands at the head of the central set of ways of the main group. Its length is parallel to the ways, and material passes through longitudinally from a receiving track for raw material at the inshore end to a loading track at the outshore end. By way of the latter track, material is distributed to the fabricated-storage spaces at the various berths. The shop, 188 x 770 ft., is subdivided into two longitudinal bays, used respectively for angle and for plate work (see sketch plan, Fig. 5).

From the receiving track, which is depressed 4 or 5 ft. so as to bring the floor of a car level with the shop

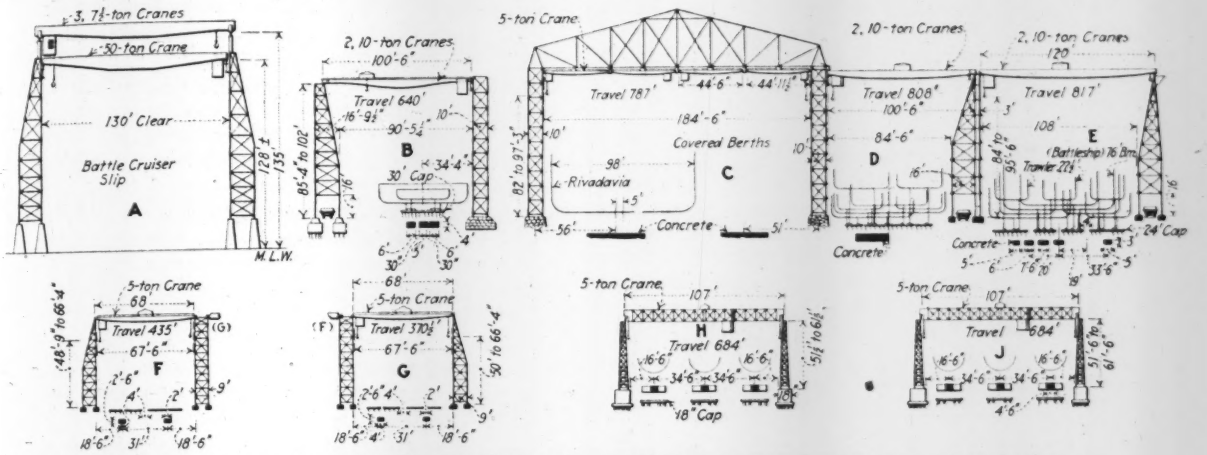


FIG. 4. CROSS-SECTION OF FORE RIVER SHIPBUILDING BERTHS; NEW BATTLESHIP BERTH AT LEFT, SUBMARINE BERTHS AT RIGHT

floor, steel and templets are delivered direct to layout areas at the head of either bay, alongside the bending furnaces. Beyond the slabs, punches, shears, and countersinks are arranged generally in three longitudinal lines in each bay, one line along either side of the bay and one down the midde. The principal equipment of the plate bay comprises six single punches fitted with Lysholm manually operated spacing tables, a middle row of double-end punches without tables, and a series of roller-bed punches. Each bay is served by a bridge crane traveling the full length of the bay. I-beam trolley runways over the outer row of angle punches, and a small number of jib cranes at individual machines, assist in handling material through the shop.

About one-third of the length of the angle bay is devoted to assembly work. Here all floors, stringers, brackets, girders and the like are assembled and riveted up; bulkheads and other large members are assembled at the head of the berth where required. All material going out of the shop passes over weighing scales before being loaded on the outbound track going to the fabricated-storage spaces.

Forging and anglesmith work is done in a shop to the left of the main building, connected by tracks with a longitudinal narrow-gage system in the main shop. Material coming from the forge shop thus reaches the punches in the farther half of the angle bay without passing through the entire length of the bay.

In the main fabricating shop itself a force of about 560 (single shift) is employed at present, and the production is about 110 tons per day. With two shifts working, an output of 250 tons per day can be reached.

Raw plate and shape stock is stored in a yard at the entering end of the shop. The yard is laid out in three 70-ft. strips, about 800 ft. long, each covered by a 10-ton gantry crane. There are no longitudinal tracks, but three spurs from the incoming railway track enter transversely at an angle, an arrangement necessitated by the limitations of the yard railway system. From cars on these spurs, material is distributed along the storage bays by the gantry cranes, and it is similarly reloaded for transfer to the fabricating shop. All plate material is racked.

Only during the past two years was hull work at Fore River put on the basis of working exclusively to and from fabricated storage. To apply this system fully, all available space near the berths had to be pressed into service for fabricated-storage purposes. The various storage areas within the yard are shown hatched on the plan, Fig. 1. Generally, it will be seen, they are reached quite directly by the track leaving the fabricating shop, though the supply to the big battleship berth is less direct, and that to the submarine berths at the north end of the yard must pass over the main track system of the yard.

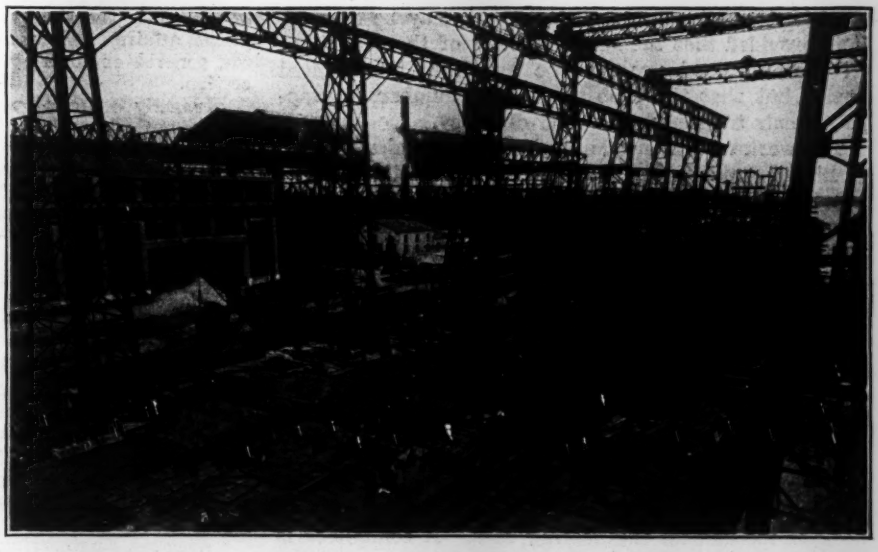


FIG. 5. TEMPORARY DESTROYER WAYS SHOW ONLY DEPARTURE FROM FORE RIVER SYSTEM OF BRIDGE-CRANE BERTH SERVICE

Some of the material is stored along the sides of the berths, as shown in Fig. 1, but this is chiefly smaller parts. Plates and other main material are stored in racks and piling spaces at the head of the berth and are handled by way of longitudinal travel of the bridge cranes.

Operating the fabricated storage is the function of a special department of the yard forces, the department of material stowage. This department, comprising about 170 men at present, is among the new operating developments of the yard, but is recognized now as being essential to systematic and well coördinated working of the hull construction. Its working is tied in to the operation of the fabricating shop by a simple but very effective routing and scheduling system, which will be described in the second part of this article.

Report on Proposed Activities of Mechanical Engineers

Committee Makes Recommendation for Greater Technical Activity and Participation in Civic Affairs

PARALLELING the work of the committee on development of the American Society of Civil Engineers, the American Society of Mechanical Engineers has had a committee on aims and organization studying its activities and external relations. The committee's report was presented at the Detroit meeting of the Mechanical Engineers in the week beginning June 15. In general, the report—approved, with some amendment, by the meeting—provides for greater technical activity and looks forward to the assumption by engineers of greater civic responsibility through a federation of engineering societies, starting with the locals and topped by a national agency.

In order that the society may adopt an active, progressive policy in place of the present passive policy, it is recommended that the constitution be amended so that the society may approve and adopt professional reports and standards. This is followed by recommendations looking to the increase of research work. That "better papers of broader scope" may be secured, it is provided that the subcommittees of the committee on meetings and program be appointed for limited terms, but that there be a sufficient number of reappointments to secure continuity of policy.

The work with student branches and technical schools of higher grade is approved and the formation recommended of a committee to deal with industrial education below college grade, the reason for the latter recommendation being "the need of the engineer for trained subordinates and industrial workers."

The constitution already permitting the formation of professional sections, a standing committee on professional sections is recommended. The Civil Engineers' development committee, on the other hand, recommended that professional sections be not established in their society.

In regard to publications, the recommendations look to an enlargement of the *Journal*, now known as *Mechanical Engineering*, and the publication of a handbook of mechanical engineering data. A committee is to be appointed "to study the possibility of a substitute for the present expensive method of publishing the *Transactions*." The recommendation that the *Journal* be made a weekly, instead of a monthly publication, was rejected by the convention.

It is recommended that membership on "any council or committee terminate automatically on account of absence or neglect, either willful or due to force of circumstances." The joint employment work of the national engineering societies is approved and a special committee appointed to study the whole question of code of ethics and its enforcement. The committee's recommendation, not concurred in by the meeting, was that the present code of ethics be abolished "as unnecessary and unenforceable."

On the subject of election of officers the committee recommended to the council of the society that the nominating committee be composed of a member from each local section, providing at the same time that each voting member of the society be assigned to a local section "exclusively for the purpose of electing a nominating committee member." This plan has a parallel in the Civil Engineers' report, wherein it is recommended that "every member of the society be a member of a local association."

The section of the report covering the relations of the mechanical engineer to the community, as amended and adopted, is printed in full below:

(Note.—In order to avoid confusion, the term "technical societies" will be used to refer to the four founder societies and such others as confine their activities to specific professional or technical phases of engineering. The term "general engineering societies" will be used to cover the federation—local, state or national—on such basis as may develop, of the various technical societies, their sections and others concerned with engineering.)

In the opinion of the committee, the relations of the engineer to municipalities can best be cultivated through group activity, proper groups being the local general engineering societies which should include engineers of all classes. In state affairs, these relations may be developed through a coalition of such local groups into state associations, while matters of general and national interest may be handled by a national organization of such local, district and state societies. Such a system of societies is considered below.

The entity of the various local sections of the technical societies should be preserved, but they should form part of the local general engineering societies. In dealing with public affairs, their members should act as members of the general engineering society and *not* of the technical section.

Distinctly technical work such as the formulating and publication of safety codes, the fixing of standards, etc., should be done by those technical societies which, jointly or severally, are concerned with the particular subject; e.g., the boiler code by The American Society of Mechanical Engineers, wiring standards by the American Institute of Electrical Engineers, etc. But the agencies for bringing about their general adoption and legalization should be the general engineering societies; local, district, state and national.

As embodying the above, the committee presents the following resolutions:

"Whereas, The Committee on Local Sections has been engaged in promoting coöperation between local sections of The American Society of Mechanical Engineers and other local engineering organizations; and

"Whereas, It is desirable that this coöperation be encouraged and further vigorously developed not only among local but also among national engineering organizations; and

"Whereas, Engineering solidarity should be established to enable the profession to more effectively serve the community at large; therefore be it

"Resolved, That the policy heretofore pursued by the Committee on Local Sections is heartily endorsed; and be it

"Resolved, That the Council of the Society should actively encourage further development of coöperation both in local organization under the leadership of local engineering societies and in state or territorial groups, which can effectively handle state or territorial problems. This cooperation to take such form as will most readily lend itself to national coöperation; and be it

"Resolved, That there should be created some agency of a national character through which the coöperation of local groups, state groups and national societies can be secured for purposes of national scope. This agency to be composed of representatives of the members of local groups, state groups and national societies. It should be an organization capable of speaking in the name of the profession; and be it

"Resolved, That The American Society of Mechanical Engineers should collect and publish in pamphlet form the various modes of coöperative organizations used in different localities, thus enabling each group of organizations contemplating coöperation to more readily select the method best adapted to their local conditions."

Acting through the organization above suggested, service to the community may best be promulgated along the following lines:

Legislation

Protection of Health, Life and Comfort.—By securing the introduction of safety codes, of which the boiler code is an example, by securing the adoption and enforcement of measures for smoke prevention, the inspection of elevators, and the use of safety methods, and appliances in the industries, etc.

Production, Distribution and Sale of Commodities.—By the establishment of standards of size, strength and quality of manufacture of products, of standards of material and standard methods of testing materials and performances.

Industries, Utilities and National Resources Owned or Controlled by Communities.—By initiating and guiding legislation for their operation, development and conservation, and particularly by developing and securing the adoption of uniform systems of accounts and reports for public utilities, *both* privately and publicly owned.

Legislation for Protecting the Public in Engineering Affairs.—By action to secure uniform State and professional laws for the registration and certification of professional engineers whose work involves the public health, safety and well-being.

Administration

Placing Engineers in Public Positions Requiring Engineering Training.—By efforts to bring about the appointment rather than the election of engineering officials, and to secure the appointment and retention of the best grade of engineers in the public service; and also by coöperation with such civic bodies as the Civil Service Reform League.

Coöperation with Engineers in Public Positions.—By encouraging such engineers to become members of the local general engineering societies, and by giving them the support of such societies when political or other influences seek to interfere with the proper exercise of their functions. The reports of such engineers may be made profitable and mutually helpful subjects of discussion and review by such societies.

Selection of Engineers to Meet Public Emergencies.—The organization of the profession through general engineering societies seems to offer the best means for the prompt direction of the talent and efforts of engineers classified as to their special abilities and experience, and would be helpful in this connection.

Enforcement of the Law.—By action in conjunction with other civic bodies rather than independently.

Public Opinion.—By an active but dignified program of education in the public press. This should be free from objectionable advertising and of a character which would broaden the public knowledge of, and its appreciation for, engineering achievements.

By active participation in the solution of the industrial problems now before us.

In his presidential address before this society in 1882, the second year of its existence, Dr. Thurston said:

Industrial Relations

"In singular and discreditable contrast with all the gain in recent and current practice in engineering, stands one feature of our work which has more importance to us and to the world, and which has a more direct and controlling influence upon the material prosperity and the happiness of the nation than any modern invention or than any discovery in science. I refer to the relations of the employers to the working classes, and to the mutual interests of labor and capital. It is from us, if from any body of men, that the world should expect a complete and satisfactory practical solution of the so-called labor problem. More is expected of us than even of our legislators. And how little has been accomplished!"

Mr. Marburg in the progress report of this committee in December last said:

"Among all the educated classes, the engineers are the one group in closest touch with labor. It is the part of wisdom and our duty to society to try to understand the strivings of the working classes for our own benefit and to interpret them to the rest of the community. If the British Labor Party has been able to frame a reconstruction program and to produce a document commanding the admiration of most thinking men, surely it behooves us, the engineers, the men of whom, on account of training and experience, industrial leadership might reasonably be expected, to discuss the mighty problems now before us."

The engineer was the first to attempt a definite solution of the problems involved; he has contributed most of the constructive work which has been done to date, and on him rests the principal burden of an adequate and constructive solution.

The political autocracies of the world have been overthrown, but industry remains to be democratized. Labor is not going to be contented with its present subservient and limited condition, and its discontent will not be ameliorated by welfare work or other manifestations of benevolent despotism. The engineer stands between opposing interests, frequently between extremists, the self-satisfied obdurate employer who still regards labor as a chattel on the one hand, and on the other the radical laborite who would confiscate all forms of property. With his analytical habit of thought, his experience in estimating and directing physical and industrial forces, he must devise industrial methods which will insure greater and more efficient production and a more equitable distribution of it, and he must take the lead in their adoption.

As outlined above, action in public affairs should be through the general engineering societies, but discussion is distinctly within the province of our own society. The committee therefore presents the following resolution:

"Resolved, That the society should enlighten its membership in regard to all Federal, state and local problems which should interest engineers, and in the solution of which their experience and training may be helpful."

Milwaukee Water-Treatment Experiments

The experimental water-filtration plant at Milwaukee, Wis., having a capacity of 250,000 gal. per 24 hours, has been in operation day and night since Feb. 1, but although it has proved satisfactory, it is too early for definite results to be reported. Four different types of mixing chambers, a settling basin and two filters are provided in the building, and there is also an ozone apparatus arranged for treating both raw and filtered water. The plant was designed by J. W. Ellms, of Cleveland, Ohio, and the experimental work is under his direction.

Engine Terminal Improvements: Pennsylvania Lines West

Heavy Traveling Crane, Circular Crane Runway, Parking Tracks With Transfer Table and Turntable, Mechanical Ashpits, New and Rebuilt Roundhouses and Smoke Exhaust System Are Features

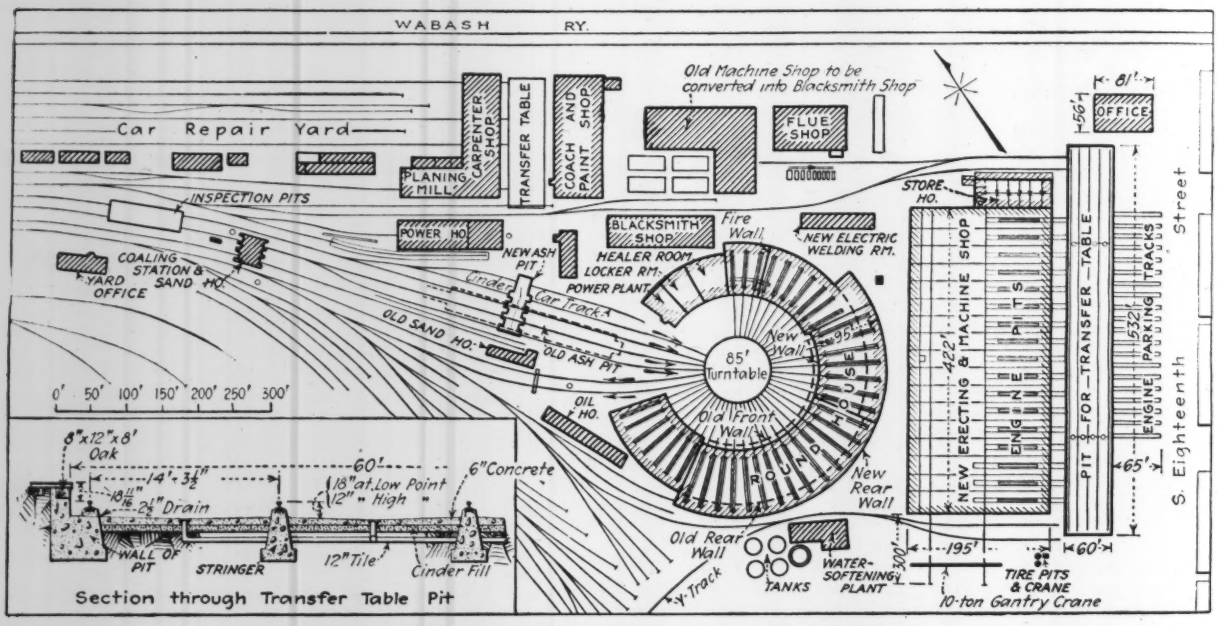
TYPICAL of extensive improvements to engine-terminal facilities on the Pennsylvania Lines West of Pittsburgh are the modernizing of the terminal at Logansport, Ind., and the construction of a new terminal at Richmond, Ind. Both of these are at division points of moderate importance, where provision has to be made for handling and cleaning about 100 locomotives daily. In the former case increased capacity has been provided on the original site, while in the latter it has been necessary to abandon the old terminal and establish a new one outside the city, the conditions being similar to those of the new terminal for the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Galion, Ohio, described in *Engineering News-Record* of Mar. 13, 1919, p. 519.

The work at Logansport included the construction of a large steel-frame locomotive-repair shop having a 250-ton, 90-ft. traveling crane, the installation of a transfer table serving this shop and a group of parking tracks, and the enlargement of a roundhouse to accommodate longer engines, together with a general revision of existing facilities. At Richmond, the prominent features include a reverse-movement entrance, a roundhouse of combined steel and concrete framing, with an overhead crane on a circular track, and an exhaust system for carrying off smoke and gases from the roundhouse. Both terminals include parking tracks and mechanically equipped ashpits, but the arrangements are essentially different, owing to local conditions and requirements. Thus, the tracks are parallel in one case and radial in the other, while the ashpits include both hopper and water-pit types. At both terminals the water for the locomotives is treated in a softening plant.

The decision to carry on heavy repairs and reconstruction of locomotives at Logansport made it necessary to establish entirely new facilities, as hitherto only light or running repairs had been made at that point. As the terminal site is on the outskirts of the city and includes a considerable area of vacant land made by filling along the river front, it was practicable and convenient to place all the additional facilities on this site. The locomotive-repair shop is the most important item of the new works, being a steel-frame building 420 x 195 ft., with exceptionally heavy construction for the 90-ft. erecting shop in order to carry the 250-ton traveling crane noted above. This crane serves the group of 17 parallel stub tracks, which are spaced 24 ft. on centers, its purpose being to transfer engines from place to place as required. The shop and its equipment were described in *Engineering News-Record* of Feb. 2, 1919, page 306.

Engine-parking tracks are arranged opposite the repair shop, and engines ready for service or awaiting general repairs are set on these open tracks, so that the roundhouse need not be used for storage, but can be reserved for engines needing light repairs or overhauling. These parking tracks are parallel stub tracks 65 ft. long and spaced 16 ft. on centers. This layout, as will be seen by the plan, fits in with the use of a transfer table to serve both the repair-shop tracks and the parking tracks.

The transfer table is 60 ft. long, of 250 tons capacity and 33 tons weight. It travels on five lines of 85-lb. rails in a pit 540 ft. long, the pit extending beyond the shop so as to enable the table to connect with yard tracks on which engines are run to and from the table. Concrete stringers carry the three middle rails, while each side rail is carried by a bench in the wall of the pit. The rails are seated on steel channels embedded in the concrete. The walls and stringers are built on solid



LAYOUT OF REVISED ENGINE TERMINAL AT LOGANSPORT, IND.

rock, and the intermediate spaces are paved with concrete sloped to drainage planes. The depth from the top of the track rail to the top of the pit rail is only about 18 in. An unusual feature of the pit is the lowering of the walls at each track to permit placing a tie on the concrete. This not only gives a good support, but admits of renewing the end ties without raising the tracks. A 75-hp. electric motor operates the table, which has a maximum speed of 100 ft. per minute when carrying full load.

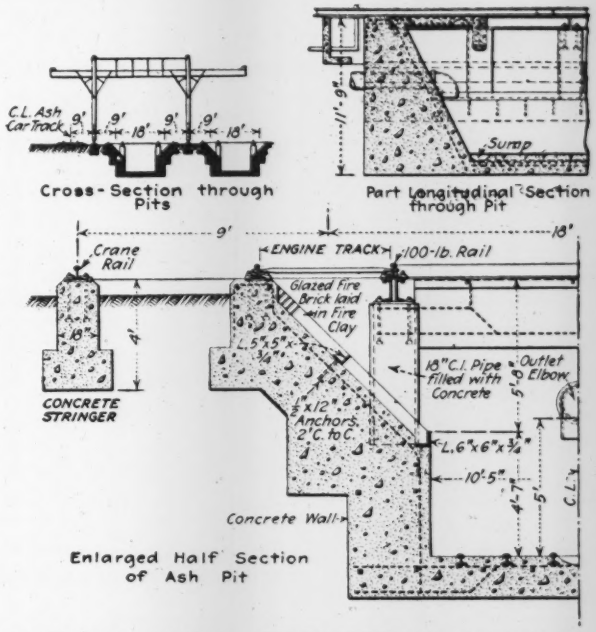
The general improvements to the engine-terminal facilities include the new inspection pits where incoming engines are examined. The use of such pits is standard practice on the Pennsylvania Lines. While it is employed also on some other railways, the more general practice is to have the inspection done in the roundhouse, using the pits where the repair work is done. Advantages of the advance inspection are that it is not hampered by and does not interfere with the roundhouse work, and that the roundhouse foreman can be notified in advance as to the class of repairs needed on each engine.

Two parallel inspection pits are provided at Logansport, about 100 ft. long and spaced 16 ft. on centers. They are of concrete, with convex floors, well drained and lighted and connected by a subway. A timber shed affords protection from the weather and has openings over the ends of each pit, so that an engine headed in either direction will stand with its smoke-stack under a ventilating opening. An office at one side of the shed is connected by compressed-air messenger tubes with the foreman's office in the roundhouse, so that the inspectors' report cards can be transmitted as soon as the inspections are completed. This enables the foreman to assign a stall for the engine and to have a crew ready to make the repairs.

A coaling station which spans two tracks and serves two other tracks by side chutes is located beyond the inspection pit. It is intended to replace the present structure by one of reinforced concrete, with a 750-ton bin, and equipped with a sand dryer and supply spouts. Water columns are so located near the coaling station as to serve both inbound and outbound engines. Water pumped from the Wabash River is treated in a softening plant before delivery to the elevated storage tanks.

New ashpits of the water-pit type, with mechanical equipment, are proposed, in view of labor shortage, the ashes being handled by a gantry or locomotive crane. These will be just beyond the coaling station, where engines have their fires cleaned or dropped. The old pit has two engine tracks carried over a flat floor on which the ash-car track is laid, so that all ashes have to be shoveled up into cars. Two parallel water-filled ashpits will serve four engine tracks located over the sloping sides of the pits, as shown in the drawings. In each track the inner rail is carried on a girder composed of a pair of channels and a top cover plate, these girders being in 13-ft. lengths, supported by pedestals of 18-in. cast-iron pipe filled with concrete and spaced 6½ ft. on centers. At these pedestals the rails are connected by tie rods to maintain the gage.

Electric Cranes Remove Ashes—For removing the ashes by grab bucket there will be an electrically operated gantry crane which straddles one pit and has cantilever girders extending over the adjacent pit on one side and the ash-car track on the other side. The crane travels on a track of 36-ft. gage, the rails of which are anchored to concrete stringers. Ordinarily the middle portion of each pit, between the tracks, is covered with sections of iron grating which are removed and replaced by the crane.



SECTIONS OF WATER ASHPITS—FOUR TRACKS SERVED BY GANTRY CRANE

Alteration or reconstruction of the roundhouse was necessary owing to the increased length of modern locomotives, a trouble which has been experienced at numerous terminals having old buildings. In order to accommodate the largest engines using the Logansport terminal, it was necessary to increase both the width of the building and the turntable. It was decided to alter the present substantial structure, having walls of stone masonry, rather than to build a new one. The alterations include the construction of a new rear wall about 23 to 27 ft. beyond the old wall and a new inner wall about 5 ft. back from the original line, thus giving a net increase of 18 to 22 ft. in width. Steel columns between the tracks, with wooden rolling doors to close the openings, compose the new front wall, an arrangement which eliminates the clearance space required formerly for swinging doors and correspondingly increases the available length of space between the house and the turntable.

As thus altered, the roundhouse is 95 ft. wide instead of about 71 ft., and the largest engines can stand either in the house or between it and the turntable. It has 38 stalls or radial tracks, with pits 80 ft. long. A portion of the house which originally accommodated seven additional tracks has been rebuilt to contain an office for the foreman, a locker and washroom for the roundhouse force and a heater room. This arrangement makes the roundhouse a self-contained unit and facilitates the work in winer.

The reduction thus made in the number of house tracks is more than balanced by the provision of the new parking tracks already mentioned. Heavy concrete walls for the engine pits form supports in jacking the engine; these walls are built on solid rock, which is only a few feet below the surface. A drop pit serving four engine pits provides for handling wheels and axles. Heavy

planks are laid outside of the track rails, and between the pits is a 4-in. plank floor on a 6-in. concrete base, Radial fire walls divide the house into five sections.

Changes in the roof were made necessary by the shifting of the walls. The roof is of timber framing, with radial beams supported by the walls and by three interior rows of posts. New trussed beams had to beplaced for the outer bay, owing to the increased span, but at the inner bay the ends of the old beams were cut off after the wall had been set back. Wooden smoke jacks used here have had a life of over 16 years. When installed they received a coat of fire-resisting paint, and soon acquired a coating of soot which protects them from fire and dry rot.

Four inbound tracks and two outbound tracks converging at the 85-ft. electrically-operated turntable provide ample capacity for handling the engines. Changes in the track layout and in the smaller buildings are included in the general improvement of the terminal. Minor new facilities include a steel-frame storehouse 109 x 50 ft. forming an extention of the new machine shop, a brick building 100 x 20 ft. for electric welding, and a two-story brick building 56 x 80 ft. for the offices, drafting room, etc., of the locomotive department.

Richmond Terminal on New Site

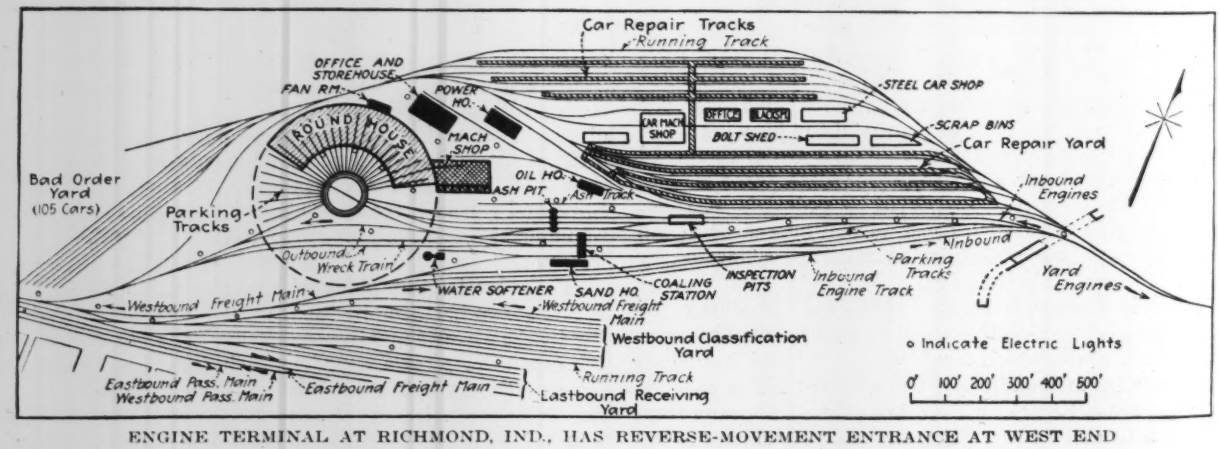
Engine-terminal facilities at Richmond, Ind., were located originally adjacent to the passenger station, in the business part of the city, but the space and facilities are inadequate for present conditions and there is no room for expansion. As it was necessary to find a site for new car-repair shops at this point, the opportunity was taken to obtain ground sufficient for the engine terminal also, and a location was selected in open country about a mile east of the city and adjacent to the freight yards.

Avoidance of reverse movements is considered a fundamental principle in the design of engine terminals, but local conditions prevented its observance in this case. The site lent itself well to the layout desired except for the fact that there was no room for the usual approach lead to the latter from the west, which is the main entrance. The difficulty was met by doubling up this lead to form a V or switchback, so that engines move first from the west to the east end of the terminal and then move back westward to the inspection pits, ashpit, coaling station, roundhouse and other facilities. Outbound engines can move directly to the main line, unless they need coal, in which case they make a similar switchback movement to reach the coaling station. Inbound engines are taken as far as the inspection pit by their road crews, and are then handled by the terminal force. Outbound engines are taken by their crews at the roundhouse or parking tracks. For yard engines and westbound road engines which leave their trains at the switching hump there is a direct entrance at the east end, which is an advantage in keeping these engines clear of the movements of other road engines.

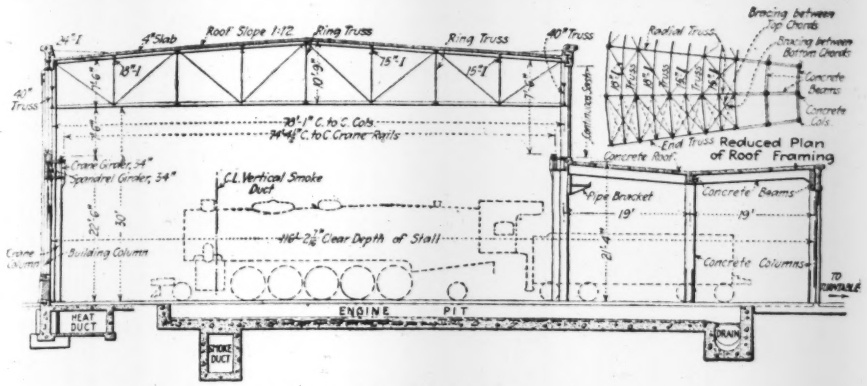
An economical design for a roundhouse which will accommodate the longest locomotives using this terminal was secured by a combination of structural-steel and reinforced-concrete framing. The engines stand in a 78-ft. bay of structural steel, having the roof supported by radial trusses located over the spaces between the tracks and giving a clear height of 30 ft. to permit of using an overhead traveling crane. Less height and space are needed for the tenders, and these are housed in a 38-ft. front bay having a low roof supported by concrete columns and girders. Each bay has a concrete roof slab. At three of the panel points of the radial trusses are lines of ring trusses, as shown on the plan, while at the other four panel points are lines of I-beam purlins supporting the roof slab. Diagonal bracing in the plane of the lower chords makes a rigid framework, and in the two end panels this is supplemented by bracing in the plane of the top chords. Wooden swinging doors fill the openings between the columns of the inner wall.

A 15-ton electric overhead crane of 74½-ft. span, traveling on a circular runway, provides for handling heavy repair parts. Wheels of different diameter are provided at opposite ends of the crane, to insure its circular movement. The runway girders are carried on posts independent of, but tied to, the columns of the structural frame. They are connected with wall or spandrel girders between the columns by means of diagonal latticing over the top and bottom chords in order to provide resistance to crane thrust and wind pressure.

Drop pits for removing wheels and axles are arranged in an unusual manner. There are three of these pits, arranged in echelon or with their ends overlapping, so as to serve four of the pits in the radial engine tracks, each drop pit extending across two tracks. As these drop pits are used only occasionally, they are covered normally by cross planks, and the floors of the radial engine pits are extended across them in the same way. The rails of the engine pits are carried across the lateral drop pits on I-beams which are made to slide or swing aside to clear the drop pit, and are held in place by T-iron braces



ENGINE TERMINAL AT RICHMOND, IND., HAS REVERSE-MOVEMENT ENTRANCE AT WEST END



ROUNDHOUSE COMBINES STEEL AND CONCRETE FRAMING

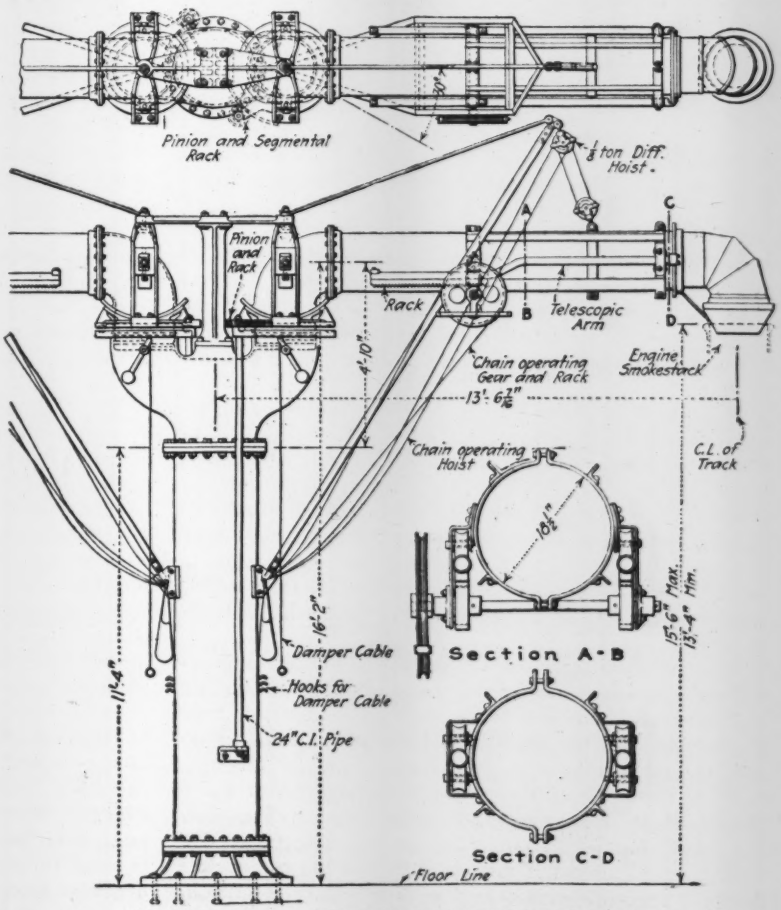
which also are made to swing aside. With an engine jacked up over its pit, the jacking truck in the drop pit is run under the axle of the pair of wheels to be removed, lowers it into the drop pit and then shifts it laterally to the adjacent empty track.

Special Provision for Smoke Removal—Removal of smoke and gas produced by the engines standing in the roundhouse or having their fires lighted is accomplished by the use of an exhaust fan. Ordinarily, the roof of a roundhouse has a ventilating opening or smokejack over each engine pit, and the engines stand with their smokestacks under these openings. To avoid the smoke nuisance at this terminal, however, owing to its proximity to a park and a residential district, all products of combustion are drawn off through floor ducts by a 73-in. exhaust fan and are discharged through an 80-ft. chimney of brick construction.

Special smokejacks are required, therefore, to connect the engine smokestacks with the floor ducts, as shown. In general, they resemble double-arm water cranes, and are placed in alternate spaces between the radial tracks, each smokejack serving two tracks. A fixed vertical 24-in. pipe mounted over the duct carries two horizontal arms having elbows which make the connection with the engine stacks. Each arm has three independent motions to enable it to be adjusted to the engine. It can be swung horizontally by gearing; it can be swung in a vertical plane by hoisting tackle operated by an endless chain; its telescopic end carrying the elbow can be racked in or out by a rack and pinion, also operated by an endless chain, in order to vary the length. A damper in the heel of each swing arm allows for adjusting the draft to meet the requirements for each engine.

Water for the terminal is obtained from the city waterworks and treated in a softening plant before being delivered to the two 50,000-gal. elevated supply tanks. A concrete coaling station with a 500-ton bin will serve four engine tracks. The powerhouse plant will supply steam heat for the building, and compressed air for tools and for testing brakes in the yards. Electric current for the shops and for lighting the buildings and yards is purchased from the city's municipal plant. For repair work there is a small machine shop forming an annex to the roundhouse, with one of the radial tracks extending into it. Pneumatic messenger tubes will connect the shop with the foreman's office, as the high price of skilled labor makes it inadvisable to have the men lose time in running about for instructions.

An ashpit of the hopper type extends across four engine tracks and has under each track a steel hopper into which the ashes are dumped from the engines. At convenient times the ashes are discharged into a small steel truck or buggy running on a track along the floor. At the end of the pit is an electric hoist which lifts the buggy and dumps it into an ash car standing on a



ROUNDHOUSE SMOKEJACK CONNECTS LOCOMOTIVE STACKS WITH EXHAUST DUCT

special railway track. This type of ashpit was described in *Engineering News-Record* of Mar. 14, 1918, p. 516.

For parking or storing road engines which are ready for service, there is a group of eight radial stub tracks served by the turntable at the roundhouse, thus allowing such engines to be kept clear of repair work in the house. Engines are parked also on a group of parallel tracks located east of the coaling station and connected to ladders at each end. This location is convenient to the east end yard connection and is of advantage in keeping the movements of parked engines free from each other and from yard and other engines. The turntable is 100 ft. long and its pit has two circular rails, one to carry the end wheels of the turntable and the other for the electric tractor by which the table is moved. This is done to prevent the sand used for the tractor from being carried by the table wheels to their axle bearings.

The design and execution of the work at both terminals are under the supervision of Robert Trimble, chief engineer of construction, Pennsylvania Lines West of Pittsburgh. S. W. Hodgin is division engineer at Richmond, with A. R. Dunn as assistant division engineer and W. C. Wolfe as resident engineer on construction. W. E. Guignon is division engineer at Logansport, with T. L. Doyle as assistant division engeener. The Austin Co., Cleveland, Ohio, has the contract for the new shop at Logansport and the engine terminal at Richmond. Other contractors at the latter point include Latham & Walters, of Indianapolis, Ind., for the car-repair plant, and Iliff Bros., London, Ohio, for the extensions to the freight yards in connection with the other terminal works.

Spillway Capacities Required for Reservoirs in Western United States

Based on a Study of the Flood Discharges of 402 North American and 60 European and Indian Records, with Curves of Probable Flood Discharges for Far Western Streams

By John T. Whistler
Engineer-Adviser, Federal Farm Loan Bureau

In connection with many investigations and reports on irrigation projects made through the Federal Farm Loan Bureau, there has been involved the question of adequacy of spillway capacity for reservoirs. A large majority of the dams for these reservoirs are of earth or earth and rock construction, and will fail immediately on their being overtopped by water from the reservoir. For reservoirs having masonry dams the failure will not follow immediately, and in many cases the dam may withstand overflow for a considerable time. Nevertheless, a masonary dam can only be considered as safer to a limited degree from overflow than an earth dam, unless designed for overflow of the entire structure, in which case the structure itself becomes a secondary or emergency spillway for the reservoir.

Much time has been spent by hydrographers and engineers on the question of floods, the probability of their occurrence, their extent and their frequency. Many efforts have been made to arrive at some expression for probable maximum flood which would be applicable to all streams, and many formulas have been devised. Probably the fullest and best discussion in recent years is that appearing in the *Transactions of the American Society of Civil Engineers*, Vol. LXXVII, pp. 564-694.

None of these formulas has proved of general applicability, because of the many varying, often unknown, and generally undeterminable conditions affecting flood discharges. Among these conditions are rainfall, snowfall, winds as effecting precipitation and as effecting drifting snow, topography or slopes, character of soil—that is, rocky, clayey or sandy——vegetation, character of stream channel, and distribution of precipitation. It has appeared almost if not quite impossible to devise a formula containing factors for these many conditions which can be of even limited value for general application.

Following are tabulations of some of the more important recorded flood discharges for streams west of the Missouri River and south of Salt Lake, streams west of the Missouri River and north of Salt Lake, streams east of the Missouri River, and foreign streams. The more important of the flood discharges given in the table are shown graphically.

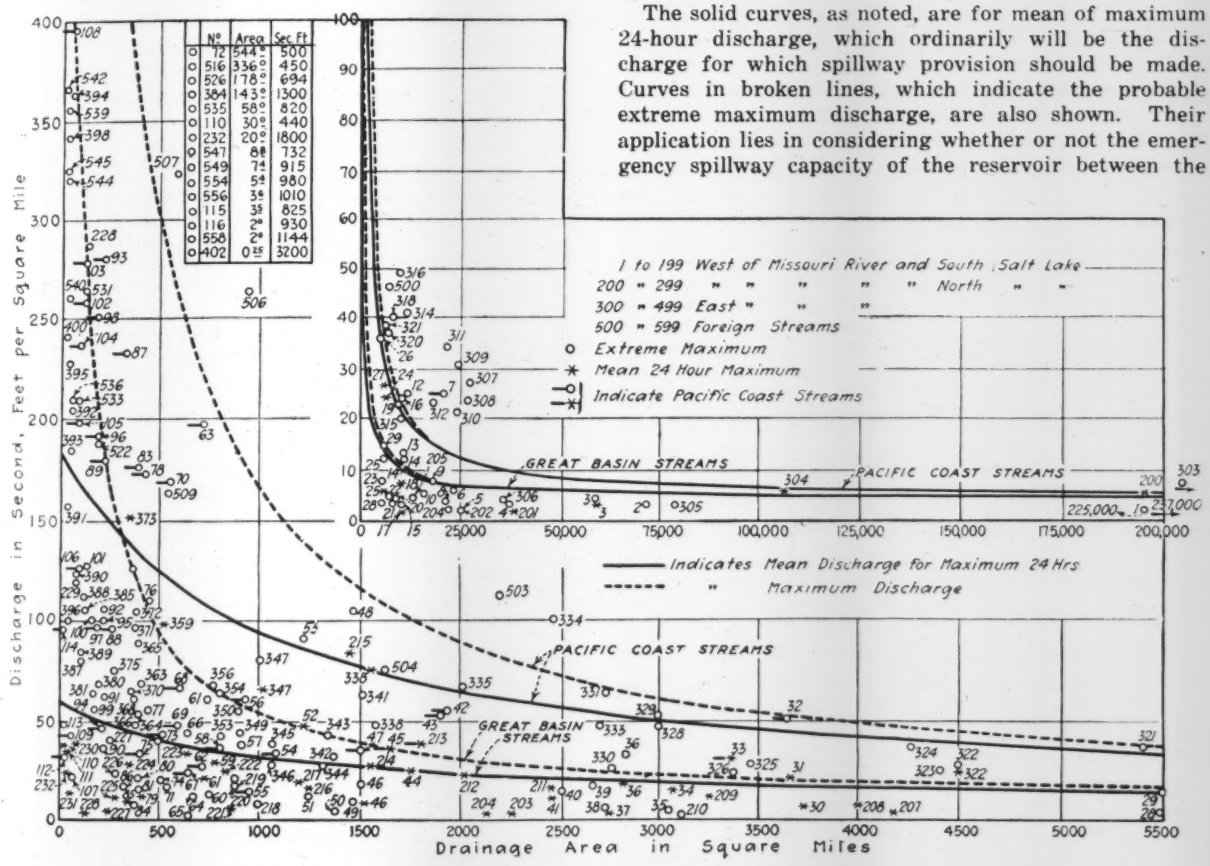
Both on account of the greater number of records for the smaller drainage areas and because by far the largest number of cases to be considered will be for drainage areas of less than 5000 square miles, the scale used for drainage areas up to 5000 square miles is larger than that for drainage areas from 5000 to 200,000 square miles, which latter doubtless exceeds any drainage area which will ever come up for consideration.

After considerable study of these flood data it has appeared impracticable to develop an expression for probable floods in terms of the conditions affecting flood discharges for even this limited region. The best that has appeared possible is to indicate the approximate minimum and maximum probable floods for which spillway capacities should be provided. These have been indicated by solid lines or curves designated "Great Basin streams" and "Pacific Coast streams," respectively. Somewhere between these two curves, it is believed, will be found the flood discharge for which reservoir-spillway capacity should be designed, for any streams west of Missouri river.

The present custom of the Water Resources Branch of the United States Geological Survey is to record for the daily flood discharge the mean of the 24-hour discharge. The difference between this and the actual maximum, which may often be for but an hour or less, is small for streams having more than 5000 square miles drainage area and is practically negligible for the larger streams. Since it is a more general custom now to record the mean of the maximum 24-hour discharge as

the maximum, and since it is not so much the actual maximum rate of discharge for the stream that interests us as that maximum rate which the spillway and emergency storage capacity between the level of the spillway crest and the top of the dam or embankment proper will be called upon to take care of, the solid curves shown are for mean 24-hour discharges. Many of the higher flood discharges for the streams with small drainage areas are far above the higher curve, but these discharges are usually for but a few hours and often for less than an hour.

The solid curves, as noted, are for mean of maximum 24-hour discharge, which ordinarily will be the discharge for which spillway provision should be made. Curves in broken lines, which indicate the probable extreme maximum discharge, are also shown. Their application lies in considering whether or not the emergency spillway capacity of the reservoir between the


No. Area Sec. Ft
1 to 199 West of Missouri River and South Salt Lake
200 " 299 " " " " North " "
300 " 499 East " " "
500 " 599 Foreign Streams
Extreme Maximum
Mean 24 Hour Maximum
Indicate Pacific Coast Streams
GREAT BASIN STREAMS
PACIFIC COAST STREAMS
Indicates Mean Discharge for Maximum 24 Hrs
" Maximum Discharge
Discharge in Second. Feet per Square Mile
Drainage Area in Square Miles

FLOODS IN WESTERN UNITED STATES, WITH PROBABLE FLOOD CURVES

1. The curves of probable flood occurrences are for the mean of the maximum 24 hours. They were developed by interpolation with reference primarily to flood-discharge records of streams in the United States west of the Missouri River. Where there did not seem to be sufficient data from streams of the region, streams east of the Missouri River were considered for shaping the curves. Data from foreign streams were tabulated, and the more prominent platted, because of their longer records, and as therefore indicating the possibilities for the streams of Western United States with longer records.

2. After the curves were platted, expressions were sought for them as follows:
q being the mean rate of discharge in second-feet per square mile for maximum 24 hours and
M being drainage area in square miles contributing to the flood:

(1) $q = \dfrac{55{,}000}{M + 1{,}000} + 5$ for the lower curve, and

(2) $q = \dfrac{180{,}000}{M + 1{,}000} + 5$ for the upper curve.

3. Expression (1) for the lower curve was almost identical with the original interpolated curve throughout. Expression (2) for the upper curve came very close to the original interpolated curve, and since it appeared fully as rational, was adopted and the curve modified accordingly.

4. These expressions may be written:

(3) $q = C\left(\dfrac{10{,}000}{M + 1{,}000}\right) + 5,$

in which C is 5.5 for the lower curve and 18.0 for the upper curve.

5. To cover the Willamette River record, No. 215, C would require to be not less than 19.5, or, say, 20. In developing the lower curve for Great Basin streams few records were available, and it is quite possible that future records of flood discharge may indicate that this curve should be lowered slightly and that C may be taken as 5.

6. Curves of maximum rate of flood discharge conform closely to (4) $q_{max.} = C\left(\dfrac{10{,}000}{M + 100}\right) + 5,$

in which $q_{max.}$ is maximum rate of discharge in second-feet and C is, as before, 5.5 for Great Basin streams and 18.0 for Pacific Coast streams, and M, as before, the contributing drainage area in square miles.

7. The Pacific Coast curve for this expression, using $C = 18.0$, is exceeded by records of but two Pacific Coast streams, No. 72, Santa Catarina, Mexico, and No. 232. Willow Creek, Oregon, the latter exceeding the curve by 16%, the former by 43%.

8. It is exceeded by the records of three streams in the Eastern United States, No 303, Ohio River at Paducah, Ky., No. 334, Miami River, Ohio, and No. 402, Beacon Creek, New York. The flood records of these three streams exceed the curve by 10, 24 and 44%, respectively. Records of three foreign streams, Nos. 503, 506 and 507, also exceed the curve by 26, 32 and 17%, respectively.

9. The last quantity in Eq. (4) has been used as the maximum for all Western streams, because such use does not materially affect the problems arising with the Federal land banks. It should vary somewhat as C, and Eq. (4) may therefore more logically be written:

(5) $q_{max.} = 5c\left(\dfrac{10{,}000}{M + 100}\right) + 1.5c,$

and similarly Eq. (3) may be written:

(6) $q = 5c\left(\dfrac{10{,}000}{M + 1{,}000}\right) + 1.5c$

in which c (minor) varies from approximately 1.1 for Great Basin streams to 3.6 for Pacific Coast streams. With this form of expression c (minor) would require to be:

6.4 and 4.3 for floods Nos. 72 and 232;
4.0, 4.7 and 6.4 for floods Nos. 303, 334 and 402; and
4.9, 5.3 and 4.4 for floods Nos. 503, 506 and 507, respectively.

10. It is noted that c (minor) = 5 is exceeded in but three of the flood records listed: No. 72, Santa Catarina, Neuva Leon, Mexico; No. 402, Beacon Creek, Fishkill, N. Y.; No. 506, Ardeche River, France.

Considering the character of at least many of these flood records, that they are rarely actual measurements made at time of flood, and that drift and ice often greatly influence the stage of the stream, it seems possible, if not probable, that $c = 5$ may represent the maximum value. That $c = 1$ represents the minimum value is not probable, since there are many streams, or stream channels, which only at rare intervals have any run-off. In the absence of records extending over a long period, or of individual studies of conditions over the entire contributing drainage area, which would appear to justify it, c (minor) = 1 may be used, and in any case this value may be considered the ordinary minimum.

spillway crest level and the top of the dam or embankment proper is sufficient to take care of the extreme maximum flood of a few hours before it falls to a discharge not greater than the capacity of the spillway.

In general, the streams of the Colorado River basin may be treated as having flood discharges but little greater, and often no greater, than the streams of the Great Basin. A very marked exception to this, however, is that of Salt River at Roosevelt Dam, Arizona, Nos. 26 and 27. The extreme maximum discharge of record for this stream falls above the upper 24-hour curve. This was in 1893. In 1891 there occurred a similar flood, the record for which is expressed in mean maximum for 24 hours. This is platted as No. 27, and is only just below the upper curve.

No. 7, Sacramento River, 1904, would indicate that the upper curve is not high enough for that drainage area. The discharge for that particular flood was not, however, the discharge at the mouth of the river, but was the sum of the flood discharges for this particular flood, of all the streams coming into the Sacramento Valley. The actual discharge at the mouth of the Sacramento River was probably much less, due to the usual "lag" and to the fact that, although the records of the flood on the many tributaries may have been for the same day, they would not reach the main stream at the same time. The position of this flood record indicates, however, a remote possibility for that stream at least, and does furnish a strong argument for not lowering the curve for Pacific Coast streams.

The record for No. 48, Canadian River, New Mexico, is for a half-hour maximum. No record for the mean 24-hour maximum was obtainable, but from the flashy character of floods in that region it is believed probable it would not be above the upper curve. It stands, however, as a further argument for not lowering the curve.

One record, No. 215, Willamette River, Oregon, plats slightly above the upper curve shown. It is probable that for this stream, which drains some of the regions of heaviest rainfall in the United States, the curve of probable maximum floods should be somewhat higher, though, notwithstanding the heavy mean annual rainfall on the north Pacific Coast as compared with the south Pacific Coast, the extreme floods do not appear to exceed greatly, if at all, those of the south Pacific Coast. See, for example, streams 70, 78, 83, 87, 93, 98, 103, etc.

Of the streams east of the Great Basin and the Colorado River basin those north of Salt Lake have flood discharges generally nearer the curve for Great Basin streams than that for the Pacific Coast streams. South of Salt Lake, however, many of the streams have discharge records as high as those of the Pacific Coast; as, for example, the Canadian River, New Mexico, No. 48, to which reference has already been made. Purgatory River, No. 61, Colorado, is comparable with McCloud River, No. 68, California. For convenience the upper and lower curves shown for streams of the Western United States are designated "Pacific Coast streams" and "Great Basin streams," respectively.

The applicability of these curves of probable flood discharge is further discussed in notes appended to the diagram and modifications of the algebraic expressions (3) and (4), for the curves, developed in expressions (5) and (6), which are adapted to all streams. These latter expressions are almost as simple, and their use is suggested.

In determining spillway capacity necessary for any particular stream, the character of spillway must be considered. Where a spillway requires control by human agency, the possibility or probability of the gate-tender not being present or of the mechanism not being operable when needed should receive weight, as these conditions are known to occur very often. Where there is intended automatic control of spillway gates, the character of such control should be considered, but in general such control should receive little weight, because it almost invariably occurs in a few years that the mechanism is neglected, and when the demand upon it comes suddenly, it fails to operate.

FLOOD DISCHARGES FOR THE UNITED STATES AND FOREIGN COUNTRIES

Streams West of Missouri River and South of Salt Lake

No.	Stream	Place	Year	Drainage Area in Sq. Miles	Discharge, Sec. Ft. per Sq. Mi.	Period	Authority
1	Colorado	Yuma, Ariz	1916	225,000	0.9	....	(1)
2	Gila	Yuma, Ariz	1916	71,000	2.7	....	(1)
3	Kansas	Lecompton, Kan	1903	58,550	4.0	....	(2)
					3.8	*	(2)
					2.0	10 da.	(2)
4	Colorado	Austin, Tex	1900	37,000	3.3	....	(3)
5	Republican	Mouth, Kan	1903	25,840	1.8	....	(2)
6	Arkansas	Holly, Colo	1908	23,000	5.9	....	(4)
7	Sacramento	All	1904	22,500	25.6	....	(5)
8	Pecos	McMillan Res., N.M.	1904	21,500	3.9	....	(5)
9	Gila	Florence, Ariz	1891	17,750	7.5	....	(6)
10	Arkansas	Near Prowers, Colo.	1904	16,000	4.4	....	(4)
					2.5	*	(4)
11	Pecos, above Hondo	Roswell, N. M.	1904	14,840	3.8	....	(5)
12	Salt	? Ariz	1891	12,000	24.7	....	(6)
13	San Juan	Shiprock, N. M.	1911	12,000	12.5	....	(4)
14	Canadian	Logan, N. M.	1894	11,440	12.3	12 hr.	(5)
					11.0	*	(5)
15	Rio Grande	San Marcial, N. M.	1904	11,250	2.8	....	(5)
					0.5	12 da.	(5)
16	Sacramento	Red Bluff, Calif.	1909	10,400	24.4	....	(8)
17	Little Colorado	Holbrock, Ariz	1905	10,000	2.0	*	(3)
18	Blue	Manhattan, Kan	1903	9,490	7.2	*	(2)
19	Sacramento	Iron Canyon, Calif.	1904	9,295	23.5	....	(5)
20	Grand	Palisades, Colo	1905	8,546	4.8	*	(3)
21	Gunnison	Whitewater, Colo.	1905	7,863	3.7	....	(3)
22	San Juan	Farmington, N. M.	1909	7,000	5.0	....	(4)
23	Pecos	Fort Sumpter, N. M.	1904	6,190	7.3	....	(5)
24	Verde	McDowell, N. M.	1893	6,000	24.0	*	(7)
25	San Juan	Bloomfield, N. M.	1911	6,000	12.0	....	(4)
					6.0	*	(4)
26	Salt	Roosevelt Dam, Ariz.	1893	5,755	36.0	....	(7)
27	Salt	Roosevelt Dam, Ariz.	1891	5,755	26.0	*	(3)
28	San Juan	Bloomfield, N. M.	1909	5,500	3.5	....	(4)
29	San Juan	Bloomfield, N. M.	1911	5,500	14.5	....	(4)
30	White	Meeker, Colo	?	3,710	5.9	*	(8)
31	Neosho	Iola, Kan	1894	3,670	20.3	*	(5)
32	Feather	Oroville, Calif.	1907	3,640	51.3	....	(8)
33	Feather	Oroville, Calif.	1904	3,350	31.5	*	(5)
34	Verdigris	Liberty, Kan	1894	3,065	16.4	*	(5)
35	Salt	Mouth, Roswell, N. M.	1904	3,050	4.1	....	(5)
36	Canadian	Taylor, N. M.	1894	2,830	32.1	7 hr.	(5)
					20.0	*	(5)
37	Duchesne	Myton, Utah	?	2,750	3.5	*	(8)
38	Saline	Beverly, Kan	1896	2,730	5.9	....	(2)
39	Pecos	Santa Rosa, N. M.	1904	2,650	17.6	....	(5)
40	San Juan	Arboles, N. M.	1911	2,500	16.0	....	(4)
41	Logan	Logan, Utah	?	2,450	11.2	*	(8)
42	No. Fork Feather	Big Bend, Calif.	1907	1,940	56.3	....	(8)
43	American	Fair Oaks, Calif.	1907	1,910	55.0	....	(8)
44	King	State Point, Calif.	1901	1,742	25.2	*	(6)
45	San Joaquin	Hamptonville, Calif.	1881	1,637	36.5	*	(6)
46	Animas	Aztec, N. M.	1911	1,500	18.0	....	(4)
					8.1	*	(4)
47	Tuolumne	Lagrange, Calif.	1911	1,500	35.1	....	(8)
48	Canadian	French, N. M.	1894	1,480	105.6	½ hr.	(5)
49	Rio Grande	Del Norte, Colo.	1911	1,475	8.1	....	(4)
50	Hondo	Roswell, N. M.	1904	1,390	4.6	....	(5)
51	Animas	Aztec, N. M.	1909	1,250	12.8	....	(4)
52	Yuba	Smartsville, Calif.	1904	1,220	49.0	*	(5)
53	Yuba	Smartsville, Calif.	1909	1,220	90.9	....	(8)
54	Merced	Nr. Merced Falls, Calif.	1911	1,090	34.1	....	(8)
55	Truckee	Nr. State line, Calif.	1907	955	16.0	....	(8)
56	Stanislaus	Knights Ferry, Calif.	1907	935	61.2	....	(8)
57	Two Butte	Arkansas Val., Colo.	1908	900	39.0	....	(4)
58	Putah	Winters, Calif.	1907	805	37.3	....	(8)
59	Stony	Fruto, Calif.	1904	760	29.2	*	(5)
60	Animas	Durango, Colo.	1909	750	13.3	....	(4)
61	Purgatory	Trinidad, Colo.	1904	742	61.0	....	(4)
					22.0	*	(4)
					7.0	5 da.	(4)

* Mean for 24 hours.

62 Santa Ynez	Lompoc, Calif.	1911	725	28.1			(8)
63 San Jacinto	Elsinore, Calif.	1916	717	195.0			(9)
64 Rio Grande	Wason, Colo.	1911	685	11.7			(4)
65 Zuni	? N. M.	1909	650	2.3			(10)
				1.7	*		(10)
66 Mora	Mora, N. M.	1904	650	43.0			(5)
				11.0	12 da.		(5)
67 Mokelumne	Nr. Clements, Calif.	1911	642	26.0			(8)
68 McCloud	Nr. Gregory, Calif.	1904	608	68.3			(8)
69 Stony	Nr. Fruto, Calif.	1909	601	48.8			(8)
70 San Luis Rey	Oceanside, Calif.	1916	565	169.0			(9)
71 Dolores	Dolores, Colo.	1911	550	18.2			(4)
72 Santa Catarina	Nueva Leon, Mexico	1909	544	500.0			(11)
73 Cosumnes	Michigan Bar, Calif.	1911	524	42.7			(8)
74 No. Fork Feather	Below Prattville, Calif.	1907	506	19.5			(8)
75 Cache La Poudre	Livermore, Colo.	1904	500	40.0			(5)
76 Troxton Canyon	E. of Kingman, Ariz.	1894	450	110.0			(5)
77 Cherry (all)	Denver, Colo.	1912	445	56.0			(12)
78 San Diego	San Diego, Calif.	1916	434	173.0			(9)
79 Carson, E. Fork	Rodenbohs, Nev.	?	414	13.4	*		(8)
80 La Plata	Pendleton, N. M.	1904	400	20.0			(4)
81 La Plata	Pendleton, N. M.	1909	400	16.0			(4)
82 Mohave	Victorville, Calif.	1903	400	33.5			(8)
83 Calaveras	Jenny Lind, Calif.	1911	395	176.2			(8)
84 Carson, E. Fork	Nr. Gardnerville, Nev.	1904	381	8.7			(8)
85 Ogden	Ogden, Utah	?	360	9.0	*		(8)
86 Conejos	? Colo.	1911	?325	19.0			(4)
87 San Luis Rey	Pala, Calif.	1916	322	233.0			(9)
88 Bear	Van Trent, Calif.	1907	263	98.1			(8)
89 San Gabriel	Azusa, Calif.	1916	222	180.0			(9)
90 Sapello	Los Alimos, N. M.	1904	221	37.0			(5)
				12.8	12 da.		(5)
91 Arroyo Seco	Nr. Soledad, Calif.	1911	215	61.9			(8)
92 Mora	La Cueva, N. M.	1904	210	106.0			(5)
				32.0	12 da.		(4)
93 San Luis Rey	Mesa Grande, Calif.	1916	209	280.0			(9)
94 Santa Ynez	Nr. Santa Barbara, Calif.	1907	207	45.7			(8)
95 Cherry (Flood area only)	Denver, Colo.	1912	200	100.0			(12)
96 San Diego	Cap. Gr. Dam Site, Calif.	1916	189	192.0			(9)
97 Sweetwater	Sweetwater Dam, Calif.	1895	186	97.5			(6)
98 Sweetwater	Sweetwater Dam, Calif.	1916	181	251.0	1 hr.		(9)
99 Cherry	? Colo. Prior to	1903	175	57.0			(6)
100 Turquillo	Mora Valley, N. M.	1904	160	100.0			(4)
				20.0	12 da.		(4)
101 Cottonwood	Morena Dam, Calif.	1916	120	128.0	2 hr.		(9)
102 Santa Ysabel	Ramona, Calif.	1916	110	258.0			(9)
103 San Jacinto	San Jacinto, Calif.	1916	108	278.0			(9)
104 Otay	Lower Otay Dam, Calif.	1916	99	238.0			(9)
105 Putah	Nr. Guenoc, Calif.	1904	91	198.9			(8)
106 Gallinas	Las Vegas, N. M.	1904	90	129.0			(4)
107 Carson, W. Fork	Woodfords, Calif.	1906	70	22.4			(8)
108 Santa Ysabel	Mesa Grande, Calif.	1916	53	395.0			(9)
109 Kosk	Nr. Henderson, Calif.	1911	52	44.3			(8)
110 Pinal (Flood area only)	Globe, Ariz.	1894	30	440.0			(5)
				35.0	*		(5)
111 Donner	Truckee, Calif.	?	30	32.7	*		(8)
112 Yuba	Bowman Dam, Calif. Prior to	1903	19	31.6			(6)
113 Mormon Canyon	Los Angeles, Calif. Prior to	1903	15.5	48.5			(6)
114 Goodyear	Goodyear Bar, Calif.	1911	12.2	96.7			(8)
115 Estanzuela	Nueva Leon, Mex.	1909	3.5	825.0			(11)
116 Cherryvale	Cherryvale, Kan.	?	2.0	930.0			(8)

Streams West of Missouri River and North of Salt Lake

200 Columbia	Cascade Locks, Ore.	?	237,000	5.9	*		(8)
201 Green	Greenriver, Utah	1897	38,200	1.8	*		(3)
202 Red	Grand Forks, N. D.	1897	25,000	1.7			(8)
203 Snake	Minidoka, Ida.	?	22,600	2.4	*		(8)
204 Green	Green River, Wyo.	?	21,384	2.9	*		(8)
205 Loup	Columbus, Neb.	1896	13,540	5.2	7 hr.		(3)
206 Missoula (Clarks Fork)	Missoula, Mont.	1899	5,960	6.0	*		(8)
207 Malheur	Vale, Oregon	?	4,190	3.5	*		(8)
208 Spokane	Spokane, Wash.	?	4,000	8.8	*		(8)
209 Bitterroot	Missoula, Mont.	?	3,260	11.5	*		(8)
210 Klamath	Klamath Falls, Ore.	1904	3,110	2.9	*		(8)
211 Boise	Boise, Ida.	1896	2,450	16.4	*		(3)
212 Rogue	Tolo, Ore.	?	2,020	23.9	*		(8)
213 Umpqua	Brockway, Ore.	?	1,800	39.3	*		(8)
214 Yakima	Umtanum, Wash.	?	1,540	26.6	*		(8)
215 Willamette	Jasper, Ore.	1909	1,450	84.1	*		(14)
216 Wenatchee	Cashmere, Wash.	?	1,250	15.2	*		(8)
217 Umatilla	Yoakum, Ore.	?	1,200	19.9	*		(8)
218 Redwater	Belle Fourche, S. D.	1894	1,010	8.0			(5)
219 Weiser	Weiser, Ida.	1896	894	20.1			(3)
220 Weiser	Weiser, Ida.	1897	894	19.2			(3)
221 Silvies	Burns, Ore.	?	865	5.5	*		(8)
222 Snake, No. Fork	Moran, Wyo.	?	820	25.5	*		(8)
223 Naches	Nile, Wash.	?	636	33.4	*		(8)
224 Umatilla	Gibbon, Ore.	?	353	28.3	*		(8)
225 Chewaucan	Paisley, Ore.	?	272	12.9	*		(8)
226 Miller	Lorella, Ore.	1907	270	24.9			(8)
227 Crow	Cheyenne, Wyo.	1904	250	40.0			(4)
				5.0	*		(4)
228 Willow	Heppner, Ore.	1903	125	288.0			(2)
				4.0	*		(2)
229 Cedar	? Wash.	1911	79	120.0			(13)
230 Kaches	Easton, Wash.	?	63	36.5	*		(8)
231 Wallowa	Joseph, Ore.	?	47	15.5	*		(8)

* Mean for 24 hours.

232 Willow (flood area only)	Heppner, Ore.	1903	20	1300.0			(2)
				25.0	*		(2)

Streams East of Missouri River

300 Mississippi	St. Louis, Mo.	1883	702,380	1.3			(8)
301 Missouri	St. Charles, Mo.	1883	530,810	1.1			(8)
302 Missouri	Sioux City, Iowa	1881	323,462	1.6			(8)
303 Ohio	Paducah, Ky.	1884	205,750	7.0			(15)
304 Ohio	Evansville, Ind.	1913	106,000	6.4	20 da.		(16)
305 Mississippi	Clayton, Iowa	1880	79,040	2.7			(8)
306 Mississippi	St. Paul, Minn.	1881	36,085	3.3			(3)
307 Susquehanna	McCalls Ferry, Penn.	1889	27,000	27.0			(5)
308 Susquehanna	McCalls Ferry, Penn.	1894	27,000	23.4			(5)
309 Susquehanna	Harrisburg, Penn.	1865 1889	24,030	30.6			(3)
310 Ohio	Wheeling, W. Va.	1884	23,800	20.8			(3)
311 Tennessee	Chattanooga, Tenn.	1867	21,380	34.4			(3)
312 Ohio	Pittsburgh, Penn.	1907	19,100	23.0			(8)
313 Alabama	Selma, Ala.	1892	15,400	9.5			(3)
314 Potomac	Washington, D. C.	1889	11,500	40.9			(3)
315 Connecticut	Hartford, Conn.	1854	10,270	20.0			(3)
316 Potomac	Point of Rocks, Md.	1889	9,654	48.9			(3)
317 Allegheny	Kittanning, Penn.	1905	9,010	26.6			(17)
318 Savannah	Augusta, Ga.	1888	7,500	40.0			(3)
319 Delaware	Trenton, N. J.	1903	7,000	36.0			(18)
320 Delaware	Lambertsville, N. J.	1841	6,855	37.1			(3)
321 Monongahela	Lock No. 4, Penn.	1888	5,430	38.1			(3)
322 Hudson	Mechanicsville, N. Y.	1913	4,500	26.7			(19)
				25.2	*		(19)
323 Kennebec	Waterville, Me.	1896	4,410	25.2			(20)
324 Kennebec	Waterville, Me.	1901	4,270	35.4			(21)
325 Mohawk	Cohoes, N. Y.	1913	3,472	28.5			(19)
326 Mohawk	Rexford, N. Y.	1892	3,384	23.1			(22)
327 Chattahoochee	West Point, Ga.	1901	3,300	26.9			(23)
328 Shenandoah	Millville, W. Va.	1896	2,995	46.6			(24)
329 Catawba	Rock Hill, S. C.	1901	2,987	50.5			(25)
330 Hudson	Glens Falls, N. Y.	1913	2,760	25.4			(26)
331 New River	Radford, Va.	1900	2,725	63.8			(8)
332 New River	Radford, Va.	1901	2,725	63.4			(8)
333 Kennebec	Above Waterville, Me.	1901	2,700	48.6			(21)
334 Miami	Dayton, Ohio	1913	2,450	100.4			(8)
335 Chemung	Elmira, N. Y.	1889	2,055	67.1			(5)
336 Kiskimineatis	Avonmore, Penn.	1908	1,720	39.1			(17)
337 Allegheny	Redhouse, Penn.	1910	1,640	25.0			(17)
338 S. Fk. Shenandoah	Front Royal, Va.	1902	1,570	48.9			(24)
339 Scioto (Lower)	Columbus, Ohio.	1913	1,570	75.8	*		(8)
340 Chattahoochee	Oakdale, Ga.	1901	1,560	31.3			(23)
341 Catawba	Catawba, N. C.	1901	1,535	61.9			(25)
342 Cheat	Morgantown, W. Va.	1911	1,380	30.3			(17)
343 Greenbrier	Alderson, W. Va.	1897	1,344	41.6			(20)
344 Youghiogheny	Connellsville, Penn.	1910	1,320	27.7			(17)
345 Genesee	Mt. Morris, N. Y.	1894–6	1,070	39.2			(27)
346 Sacandaga	Hadley, N. Y.	1913	1,060	27.4			(19)
347 Scioto (Upper)	Columbus, Ohio. Waterworks Dam.	1913	1,032	80.8			(8)
				65.9	*		(8)
348 Clarion	Clarion, Pa.	1905	910	43.2			(17)
349 Schoharie	Fort Hunter, N. Y.	1913	909	44.6			(19)
350 Schoharie	Fort Hunter, N. Y.	1901	900	55.1			(19)
351 Black	Lyons Falls, N. Y.	1869	897	46.0			(22)
352 Passaic	Dundee Dam, N. J.	1902	825	30.1			(28)
	Dundee Dam, N. J.			28.6	*		(28)
353 Passaic	Dundee Dam, N. J.	1903	825	43.5			(29)
				41.3	*		(29)
354 Raritan	Bound Brook, N. J.	1882	806	64.5			(3)
355 Hudson	North Creek, N. Y.	1913	804	35.1			(19)
356 Youghiogheny	Confluence, Penn.	1888	782	59.0			(3)
357 Hoosic	? N. Y.	1913	605	36.0			(19)
358 Farmington	? Conn.	?	584	41.7			(30)
359 Olentangy	Columbus, Ohio.	1913	520	98.0	*		(8)
360 Ausable	? N. Y.	1913	487	45.2			(19)
361 Cattaraugus	? N. Y.	1913	467	53.6			(19)
362 Casselman	Confluence, Penn.	1907	448	43.9			(17)
363 Stony	Johnstown, Penn.	?	428	70.0			(3)
364 Hiwassee	Murphy, N. C.	1899	410	54.5			(23)
365 Pacolet	Pacolet, S. C.	1903	400	89.0			(2)
366 Middle Oconee	Athens, Ga.	1902	395	49.5			(23)
367 Black Lick	? Penn.	1907	386	51.0			(17)
368 Pompton	Two Bridges, N. J.	1903	380	61.6			(3)
369 Rondout	Rosendale, N. Y.	1910	380	51.3			(31)
370 Esopus	Mount Marion, N. Y.	1910	378	65.3			(31)
371 West Canada	Trenton Falls, N. Y.	1901	376	96.5			(26)
372 West Canada	Hinckley, N. Y.	1869	372	104.6			(26)
373 Great	Westfield, Mass.	?	350	151.4	*		(5)
374 Croton	Croton Dam, N. Y.	?	339	74.9			(32)
375 Piscataquis	Foxcroft, Me.	1809	286	77.6			(33)
376 Salmon	? N. Y.	1913	260	41.6			(19)
377 East Canada	? N. Y.	1913	256	54.3			(19)
378 Toccoa	Blueridge, Ga.	1901	231	53.2			(22)
379 Catskill	S. Cairo, N. Y.	1901	210	100.0			(34)
380 Fishkill	Glenham, N. Y.	1902	198	69.2			(35)
381 Fish, East Br.	? N. Y.	1913	169	65.1			(19)
382 Ramapo	Pompton, N. J.	1882	160	65.9			(36)
383 Turtle	E. Pittsburgh, Penn.	1904	146	64.2			(8)
384 Devils	Nr. Mouth, Iowa	1905	143	1300.0			(3)
385 Ramapo	Mahwah, N. J.	1903	118	105.1			(5)
386 Nashua	? Mass.	1848	109.0	104.5			(22)
387 Fish, East Br.	Point Rock, N. Y.	1897	104.3	80.5			(34)
388 Tohickon	Mt. Pleasant, Penn.	1885	102.0	112.5			(37)
389 Wanaque	Pompton, N. J.	1910	101.0	83.6			(36)
390 Rock	Washington, D. C.	?	77.5	126.3			(38)
391 Nine Mile	Stittvile, N. Y.	1898	62.6	124.9			(22)
392 Conemaugh	Johnstown, Penn.	1889	48.6	205.8			(8)

*Mean for 24 hours.

393 Six Mile	Ithaca, N. Y.	1905	46.0	185.0	.....	(3)
394 Elkhorn	Keystone, W. Va.	1901	44.0	363.0	.....	(25)
395 Sawkill	Kingston, N. Y.	1896	35.0	228.6	.....	(39)
396 Bear Grass	Louisville, Ky.	1908	27.5	100.0	.....	(8)
397 Pequonnock	Bridgeport, Conn.	1905	25.0	157.0	.....	(3)
398 Cane	Bakersville, N. C.	1901	22.0	341.0	.....	(25)
399 Stony	Boston, Mass.	?	12.7	121.0	.....	(5)
400 Mill	Sherburne, N. Y.	1905	9.4	241.0	.....	(3)
401 Skinner	Mannsville, N. Y.	1891	6.4	124.2	.....	(22)
402 Beacon	Fishkill, N. Y.	1897	0.25	3200.0	.....	(34)
	Foreign Streams					
500 Loire	France	?		6,945	46.0	(8)
501 Durance	Bonpas, France	1886		5,714	37.1	(8)
502 Neckar	Germany	?		4,770	33.0	(8)
503 Loire	France	1846		2,200	113.0	(8)
504 Rhine	Germany	?		1,620	75.0	(8)
505 Ombrone	Italy	?		1,620	43.0	(8)
506 Ardèche	France	1827		938	264.0	(8)
507 Towbrapoorny	India	?		587	324.0	(8)
508 Kinzig	Germany	?		550	77.0	(8)
509 Tessin	Bellinzona, Italy	?		541	165.0	(8)
510 Lausitzer	Germany	1880		481	60.0	(8)
511 Olsa	Germany	?		435	77.0	(8)
512 Kinzig	Germany	?		386	100.0	(8)
513 Iller	Germany	?		367	74.0	(8)
514 Ubaye	Mouth, France	1843		361	127.1	(8)
515 Bleone	Mouth, France	1843		351	115.7	(8)
516 Irrity	India	?		336	450.0	(8)
517 Ostrawitza	Germany	1894		313	110.0	(8)
518 Olsa	Germany	?		291	72.0	(8)
519 Murg	Germany	?		246	100.0	(8)
520 Serein	France	?		226	78.0	(8)
521 Cure	France	?		208	77.0	(8)
522 Bruna	Italy	?		189	189.0	(8)
523 Elz	Germany	?		185	86.0	(8)
524 Murg	Germany	?		184	123.0	(8)
525 Queis	Germany	1888	183.5	164.0		(8)
526 Ardeche	Aubanas, France	1890		178.0	694.4	(8)
527 Wiese	Germany	?		163.0	108.0	(8)
528 Brenne	France	1874		145.0	86.0	(8)
529 Mandan	Germany	1890		119.0	135.0	(8)
530 Wittig	Germany	1880		122.0	122.0	(8)
531 Queis	Germany	1888		116.0	264.0	(8)
532 Serein	France	?		108.3	98.0	(8)
533 Stream in	Switzerland	?		87.5	210.0	(8)
534 Toss	Germany	1876		63.0	135.0	(8)
535 Pliessnitz	Germany	1890		58.0	820.0	(8)
536 Mandan	Germany	1887		50.2	210.0	(8)
537 Zacken	Germany	?		42.5	490.0	(8)
538 Bargaglino	Genoa, Italy	1892		35.6	485.0	(8)
539 Eyach	Balingen, Wurttemberg	1895		34.7	356.0	(8)
540 Allaciente	Italy	?		32.4	260.0	(8)
541 Torside and Rh'd Res.	England	1852		24.1	160.0	(8)
542 Landwassar	Germany	1887		20.1	365.0	(8)
543 Medlock	England	1857		18.8	160.0	(8)
544 Woodhead Reservoir	England	1849		11.0	320.0	(8)
545 Brook near	Dublin, Ireland	1891		10.8	325.0	(8)
546 Furens	St. Etienne France	1849		9.6	478.0	(8)
547 Bargaglino	Above Genoa, Italy	1892		8.8	732.0	(8)
548 Stream in	Hungary	1875		7.7	400.0	(8)
549 Kemlitz	Germany	1887		7.4	915.0	(8)
550 Eyach	Margarethausen, Wurtemberg	1895		7.3	788.8	(8)
551 Nebenwasser	Germany	1887		7.2	490.0	(8)
552 Spree	Germany	1887		6.7	930.0	(8)
553 Landwasser	Germany	1887		6.1	830.0	(8)
554 Kemlitz	Germany	?		5.4	980.0	(8)
555 Landwasser	Germany	1887		3.8	895.0	(8)
556 Wittgendorfbach	Germany	1887		3.6	1010.0	(8)
557 Schopsbach	Germany	1887		3.3	455.0	(8)
558 Dittelsdorfwasser	Germany	1887		2.0	1144.0	(8)
559 Willgendorfbach	Germany	1887		1.3	1115.0	(8)

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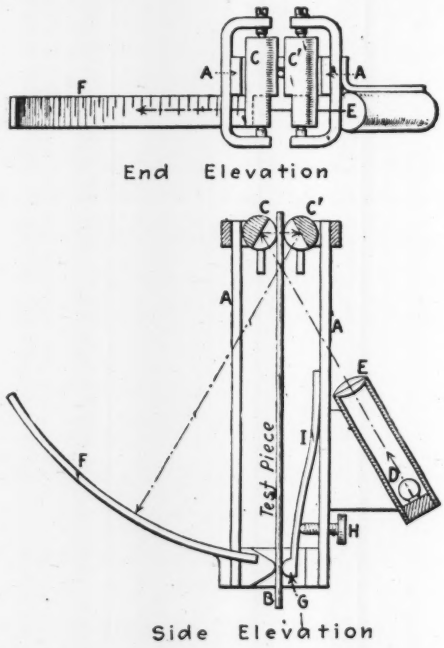
*Mean for 24 hours.

Mirror Extensometer for Testing Wire

A SIMPLE and yet highly precise extensometer constructed in the past year at the laboratory of the Westinghouse Electric & Manufacturing Co., and described by T. D. Lynch and P. H. Brace before the American Society for Testing Materials, is shown by the drawing below. It is of the mirror type, but utilizes a reflection from two moving mirrors in succession, so that the rotation of the contact rollers which constitute one of the extensometer contacts is multiplied four times.

Two elastic steel strips, *A A*, connect the lower contact block, *B*, with the upper contact rollers, *C*. The block, *B*, is held to the wire (or ribbon, as the extensometer is intended for both classes of material) by the spring jaw, *G*, which may be clamped hard by the thumb-screw, *H*. The rollers *C* and *C'* are held against the specimen by the spring of the pieces, *A*, and are turned as the specimen stretches or shortens. At one side a tube containing a straight filament galvanometer lamp, *D*, is attached, throwing a ray to the mirror on the roller, *C*, whence it is reflected to *C'* and to the curved scale *F*.



DETAILS OF MIRROR EXTENSOMETER

In the instrument as constructed the scale was 500 mm. long, and the value of a scale division, as determined by calibration, was 0.00008233 in. Thus, by estimating to one-fifth division, changes of length as small as 2/100,000 in. may be read.

Comparison of Five Railway Bridge Specifications

Proposed Revision of A. R. E. A. Standard Limited to Spans Under 300 Feet — Great Increase in Detail Over Present Standard and Three Other Specifications — Secondaries To Be Computed

WITH the revision of the American Railway Engineering Association's long-established steel bridge specifications, now in progress, the determinative features of bridge design and construction are being discussed more actively than for years past. A tabular comparison of the revision (so far as it has yet proceeded) with four other bridge specifications has therefore been prepared by *Engineering News-Record* as information on present tendencies.

While the association, at its meeting last March, declined to accept the revision as drafted, and referred it back to the committee for reconsideration, yet the redraft which the committee is to prepare by next year is not likely to depart from the general lines of the first draft. The latter, therefore, is included in the table as "Proposed A. R. E. A. Specification." Because of the great influence exerted by the present A. R. E. A. specification and the probably equal influence of the new specification (when adopted), together with the fact that the revision represents a fundamental change, comparison is made with the existing or "Old" A. R. E. A. specification and with three widely-known railway specifications, covering 15 years of practice. The earlier part of this period is represented by the Old A. R. E. A. (drawn up in 1904, adopted in 1906, and slightly revised in 1910), and the Southern Pacific specification (adopted in February, 1904, and revised in September, 1909). More modern views are represented by the Pennsylvania R.R. specification (Oct. 1, 1916) and the New York Central Lines specification (1917).

Two Types of Specifications

Two of these specifications, the Southern Pacific and the Pennsylvania, are of the "min-max" type—that is to say, they increase the live-load stress or decrease the unit stress according to the ratio of minimum to maximum stress in the member. The other three use an impact formula based on load length giving maximum stress.

The proposed A. R. E. A. specifications is limited to spans not exceeding 300 ft. Prior bridge specifications have contained no specific limit of application, but it has been the general view among railway bridge engineers that any bridge of special magnitude constitutes a problem beyond the reach of ordinary specifications.

Great increase of detail characterizes the more recent specifications. The number of clauses in the Southern Pacific is 102, in the Old A. R. E. A. 183 (including 20 on erection), in the Pennsylvania 135, in the New York Central 298, and in the Proposed A. R. E. A. 317 (including 24 on erection). The increase is due to covering more fully the minute details of design practice.

Increase of Train Loading

Increase of train loading, one of the most prominent characteristics of bridge development, is represented by the change from E40 in the old to E60 in the Proposed A. R. E. A. specification. The New York Central uses E70. Loadings differing from the Cooper are represented in the other two. None make allowance for light-traffic lines, though it was urged at the A. R. E. A. meeting last March that a general requirement of E60 would make the specification unacceptable for roads outside the heavy-traffic territory. Two separate engine types, as alternates, are specified by the Pennsylvania.

Some striking characteristics of the development represented by the five specifications tabulated may be stated as follows: Requirements as to material and tests have undergone substantially no change (only the Pennsylvania provides a drifting test for ductility). Unit stresses also have not changed perceptibly, although there is a slight tendency toward higher tensile and lower compressive unit stresses today as compared with 15 years ago. The only large change in the matter of stresses is in the column formula. Here the proposed A. R. E. A. specification follows the radical course of abandoning the straight-line and Gordon types and adopting a parabolic formula, which has not been in practical use for a quarter century. At the same time, a very low unit stress is proposed. In the latter regard the influence of the column committee of the American Society of Civil Engineers is evident, though the A. R. E. A. committee obviously disagrees with the A. S. T. M. committee's conclusions, since it uses a higher base stress and reduces more sharply for high length ratios.

Differences Between the Specifications

Marked variations between the several specifications appear in many clauses of incidental rather than fundamental importance. A few of these may be mentioned. Splicing requirements differ materially; two specifications call for full splicing, while the others accept a 50% splice (of compression members) when all four sides of the member are spliced. An unusual feature is the New York Central's requirement of 10 % excess in tension splices.

There is somewhat erratic variation on expansion, which ranges from 1 in. in 80 ft. of span length to a temperature change of 150°. Nothing is said as to floor expansion except in the Proposed A. R. E. A., which requires a joint in the floor for lengths over 250 ft. No specific provisions for the transfer of lateral forces at the expansion end are made. Only two specifications require that the rollers should be geared to the shoe plates.

In the matter of camber the range is from the general specification of the old A. R. E. A., that the stringers shall be straight under full load, to the New York Central clause requiring an increase in top-chord length of $\frac{1}{8}$ in. per 10 feet.

Punching and Reaming

Construction clauses, as distinguished from those governing design, center in the requirements as to punching, reaming and drilling, and as to field connections. With respect to punching, there is an evident progression toward higher (and more expensive) workmanship. The older specifications do not require drilling and allow punching even in main material for certain thicknesses, while the recent specifications virtually eliminate full-size punchings and require all material above $\frac{3}{4}$ in. to be drilled; but more of the specifications fix a maximum for the thickness of material that may be used. Again, the newer specifications require field connec-

Outstanding Features of Five Railroad Bridge Specifications

(Figures in Parentheses Refer to Clause Numbers)

A. R. E. A., PROPOSED	A. R. E. A., 1910	SOU. PAC.-UNION PAC. COMMON ST'D. 1909	PENNSYLVANIA, 1916	NEW YORK CENTRAL, 1917
General Features of Design				
(9)–Beams, to 35 ft.; plate girders 100–125 ft.; riveted trusses 100-300 ft.; pin-connected, 150-300 ft.	.....	(37)–Beams, to 19 ft., plate girders 19–100 ft.; riveted trusses 100-150 ft.; pin-connected, 150 ft. up. (46)–Trusses, 6 panels or less, riveted.	.....	(11)–Beams up to 30 ft.; plate girders 30–125 ft.; riveted trusses 125-200ft.; pin-connected, 200 ft. up. Limits varied at discretion of engineer. (86)–Solid floor type preferred (14)–Generally not less than 1/15 span.
(12)–Same as (3), A.R.E.A., 1910. (52)–Min. depth ratio; trusses 1/10; girders 1/12, beams and solid floors 1/15.	(3)–Min. spacing 1/20 span or to prevent overturning. Max. panel 1¼ truss spacing. (32)–Min. depth ratio; trusses 1/10; girders 1/12.	(40, 41)–Deck girders and trusses spaced 7 to 14 ft., as specified.	.....	
(13)–Clearance, 15x22 ft.	(2)–Clearance, 14x22 ft.	(38)–Clearance, 15x24 ft.	(4)–Clearance, 15x22 ft.	(15)–Clearance, 15x22 ft.
Live Loads				
(20)–Coopers E60 or 2–75,000-lb. axles, 7 ft. centers.	(7)–Coopers E40, or 2–50,000-lb. axles, 7 ft. centers.	(17)–Cooper's E55 eng. and train 5000 lb. per foot.	(8)–2 special engs., 70,000 or 66,000 lb. on main axles, and train 5500 lb. per foot.	(23)–Spans 200 ft. or less, Coopers E70; over 200 ft., Coopers E65, or 2–85,000-lb axles 7.5 ft. centers.
(22)–Same as (23) New York Central, 1917.	.....	.....	.....	(23)–For 2 tracks, 95%; 3 tracks, 90%; 4 tracks, 85% of live load.
(3)–Floor beams, min. 15,000 lb. per ft. of track. (25)–Ballasted floor, live load uniform over 10 ft. width.	.....	.....	.....	(24)–Floors solid bridges, 18,000 lb. per ft. of track. (25)–Uniform over 10 ft. width. (26)–Deck girders, 18,000 lb. per ft. of track for flange rivets
Impact				
(23)–100% on ties. (28)– $I = \frac{300}{300 + L^2/100} S$ I = Impact. L = Span length in ft.; zero for floors with transverse beams. S = Computed max. l.l stress.	(5)–100% on ties. (9) $I = \frac{300}{L + 300} S$ L = Total length of loaded track in ft.	(See unit stresses)	(See unit stresses)	(29)– $I = \frac{30{,}000}{30{,}000 + L^2} S$ Min. 20% L = Span length, in ft. (30)–Solid floors with beams. I = 100%. (31)–Where speed 20 m.p.hr. or less, I is ¾ above.
Lateral Forces				
(32)–Moving, 30 lb. per sq.ft. on 1½ vert. proj. (min. 200 lb. on loaded, 150 on unloaded chord) and 600 per ft. at 8 ft. above rail; alternate (34)–Moving load 50 lb. on 1½ vert. proj. (33)–Empty cars 1200 lb. per ft.	(10)–Moving, 200 lb. per ft. 10% l. l, one track. (11)–Viaduct towers, 50 lb. per sq.ft. on 1½ vert. proj. unloaded, or 30 lb. per sq.ft. and 400 lb. per ft. 7 ft. above rail; empty cars 1200 lb. per ft.	(18)–Wind, 30 lb. per sq.ft. on surface and 10-ft. train 2½ ft. above rail, or 50 lb. per sq.ft.; min. 500 lb. per ft., 300 lb. moving for loaded chord and 150 lb. fixed for unloaded chord. Viaducts, 60 lb. per sq.ft. loaded; 100 lb. per sq.ft. unloaded. (19)–Min. train 800 lb. per ft.	(9)–Wind, 50 lb. per sq.ft. and 10-ft. train 2½ ft. above rail. (10)–Empty cars 1,000 lb. per ft.	(37)–Moving, same as (32) new A.R.E.A., except 360 lb. at 8 ft. above rail. (40)–Empty cars, 1,000 lb. per ft.
Centrifugal Force				
(36)–Same as (36) New York Central, 1917	(13)–Computed from speed of 60–2.5 D (D = degree of curve).	(21)–4½% of live load, all tracks, per deg. of curve, 5.5. ft. above rail.	(12)–Specified uniform loads, varying with span and deg. of curve.	(36)–Percentage of l.l from 2.5% for 20′ curve to 10% for 2° and over.
Longitudinal Force				
(37)–20% live load on one track only, 6 ft. above rail. If absorbed by friction or continuity, 10%.	(12)–20% of live load, at top of rail.	(20)–20% of live load.	(11)–20% of train load.	(34)–20% of live load.
Allowable Unit Stresses				
(39)–Tension 16,000 Comp. $13{,}000 - \frac{1}{2}(l/r)^2$ Web shear 10,000 Shear, rivets and pins 12,000 Bearing, rivets and pins 24,000 Reduced 25% for field csk. and floor conn. rivets and turned bolts. Bending, beams 16,000 pin 24,000 (41)–Diagonal tension, 16,000	(14–19)–Tension, 16,000 Comp. $16{,}000 - 70\,l/r$ Max., 14,000 Web shear, 10,000 Shear, rivets and pins, 12,000 Bearing, rivets and pins, 24,000 Field rivets, shear 10,000 bearing 20,000 Bending, beams 16,000 pins 24,000	(23)–Tension: Bars 8,500 (1+min./max.). Plates or shapes. 8,000 (1+min./max.). Floorbeam hangers, 6,000 Comp. If l/r exceeds 40, reduce tension values by 35 l/r, both ends fixed, or by 45 l/r, fixed and round. Web shear, 6,000 Pins and rivets — shear 7,500, bearing 15,000; hand-driven 20% less; knee braces, 50% greater. Beam bending, 7,000 (1 +min./max.). Pin bending, 18,000	(13–16)–Tension 16,000 Comp. $\frac{16{,}000}{1 + \frac{l^2}{13{,}500\,r^2}}$ Live load stress mult. by $(1 + k)$; k is impact factor depending on min./max. (17)–Long hip verticals, 25% excess; short hangers and posts 50% excess. (28)–Rivet shear, 12,000 (27) –bearing, 24,000 Pin bearing, 25,000 (30)–Field rivets increased 30% in floors, elsewhere 20%; if power riveters, half as much. (37)– Bending, beams 16,000 pins 25,000	(41)–Tension, 18,000 Comp. $16{,}000 - 70\,l/r$ with max. 15,000 Web shear, 13,500 Shear, rivets and pins, 13,500 Bearing, rivets, 27,000 Pins, 24,000 (If reversal, 12,000) (42)–Reduce 25% for field rivets, etc. Beam bending, 18,000 Pin bending, 24,000 (41)–Diagonal tension, 18,000
Stress Reversal and Provision for Future Live Load				
(44)–Same as (22) A. R. E. A., 1910., omitting "so increased."	(22)–Increase each by 50% smaller; connections for sum of stresses so increased. (23)–Use ¾ d.l. to counteract l.l.	(24)–Increase each by 80% smaller. Min. of each taken as zero.	(22)–Increase, as specified by factor k. (25)–100% increase l.l. add area if stress exceeds twice allowable. Provide counters	(47)–Increase each by 80% smaller; connections for sum. (46)–Use 70% d.l.
Combined Stresses				
(46)–Axial plus bending stress (incl. effect floor beam deflection) within allowable axial. (47)–Incl. lateral or long'l stress, increase allowable 25%. (46)–Contin. chords, ¾ simple beam bending.	(24)–Axial plus bending stress, within allowable axial. (25)–Incl. lateral or long'l. stress, increase allowable 25%.	(31)–Axial plus bending stress, increase axial 10%. (25)–Incl. wind and centrif. stress, increase allowable 30%.	(24)–Bending and secondary stress to be provided for. (21)–Including wind, allow 20,000. (23)–Contin. chords, ¾ simple beam bending.	(48)–Eccentric and bending stress combinations, within allowable axial. (38)–Wind stress only if exceeds 25% other combined stresses. (48)–Contin. chords, ¾ simple beam bending.
Secondary Stresses				
(48)–Avoid as far as possible. Unit stress increased ¼ for combination. Compute when width of member exceeds 1/10 length and for sub-panel trusses.	.....	.....	.....	(48)–Compute stresses due to rigidity of joints and deflection. Unit stress increased ¼ for combination.

OUTSTANDING FEATURES OF FIVE RAILROAD BRIDGE SPECIFICATIONS—*Continued*

(Figures in Parentheses Refer to Clause Numbers)

A. R. E. A. PROPOSED	A. R. E. A. 1910	SOU. PAC.-UNION PAC. COMMON ST'D, 1909	PENNSYLVANIA, 1916	NEW YORK CENTRAL, 1917
Special Design Requirements				
(57)–Connections equal to member, but see (44). (27)–Only ¼ weight ballasted floor considered. (59)–Only 50% unconnected leg of L in tension (lug L not considered to connect); double L members, 90% net area if both legs connected.	(37)–Connections equal to member, but see (22).	(64)–Details should be 10% stronger than member. (65)–Connections equal to member unless allowed otherwise. (61)–Angles in tension shall be connected by both legs. (29)–Increase I. I. 80% for counters with 80% increase allowable stress (32)–Struts for 10,000 lb. on attached rods.	(52)–Bracing connections of greater strength than member.	(53)–Connections 1.5 strong er than member. (56)–Only 50% unconnected leg of L in tension; 90% net area if both legs connected. (52)–Material over 1 in. thick only by special permission.
Limiting Length Ratio (Compression Members)				
(50)–Main members, 100; bracing, 120. (51)–Riveted tension members, 200.	(20)–Main members, 100; bracing 120. (21)–Riveted tension members, 200.	(23)–Length 45 x least width.	(20)–General, 80; wind bracing, 120.	(49)–Main members, 100; bracing 120.
Minimum Thickness				
(146)–Gussets, ½ in. (58)–Except fillers, ⅜ in. If corrosive influence, increase thickness, or prevent.	(38–Except fillers, ¼ in.	(59)–Counters or diagonal rods min. 3 sq. in. (67)–Except fillers, 5/16 in.; webs of girders or chords, ¼ in.	(38)–Except fillers, ¼ in., lateral or sway rods; min. 1 sq. in.	(137)–Gussets, ½ in. (52)–Except fillers and lacing, ¼ in. and 5/16 in., respectively.
Proportioning Compression Members, Etc.				
(66)–Same as (44) A. R. E. A., 1910. (67)–Stringers, min. thickness 1/10 outstanding leg; main members, 1/12; bracing, 1/14. (70)–Lacing, for shear 2% of axial stress. (74)–Min. length ratio of flange between lacing, 40.	(44)–Web thickness 1/30 width between rivet lines; cover, 1/40. (45)–Flange Ls, min. thickness 1/12 outstanding leg. (47)–Lacing, for shear equivalent to unit stress of $70\,l/r$. (50)–Flanges between lacing strong as member.			(66)–Same as (44) A.R.E.A. 1910. (74)–Lacing for shear of $320\,Ar \div c$; A = area, r = radius gyr., axis perp. to lacing plane, c = distance axis to extreme fiber. (75)–Flanges between lacing strong as member.
Splice Details				
(75–76)–Same as (51) A. R. E. A., 1910.	(51)–Faced comp. joints spliced four sides, 50% gross area; all other joints fully spaced.	See (64) and (65) under special design requirements.	(56)–All joints in riveted work fully spliced.	(54)–Tension splice 10% excess, comp. member fully spliced.
Forked Ends				
(83)–Same as (53) A. R. E. A., 1910.	(53)–Jaws twice area of member; avoid if possible.			(136)–Jaws 20% greater area than body.
Expansion, Etc.				
(89)–1 in. per 100 ft.; spans over 250 ft., joints in floor. (90)–Same as (60) A. R. E. A.; 1910. (92)–Rollers over 6 in. geared to upper and lower plates.	(59)–¼ in. per 10 ft. (60)–Spans over 80 ft., end on rollers. (62)–Segmental rollers over 6 in. geared to upper and lower plates.	(70)–Variation 150° F. (43)–Spans over 75 ft., end on rollers. (44)–Pin bearings over 75 ft.	(44)–Variation 100° F. (45)–Spans over 70 ft., end on rollers.	(55)–1 in. per 100 ft. (124)–Spans over 80 ft., and on rollers, hinged bearings.
Truss Camber				
(142)–Equal to d.l. plus l.l. deflection.	(81)–Stringers straight under full load.	(58)–At least 1/1500; pins on arc of circle. (56)–Ties gained to take out camber of floor under d.l.	(50)–Equal to deflection under total load plus 1/3000 span.	(130)–Increase top chord ¼ in. for each 10 ft.
Workmanship				
(212)–Bracing up to ¾ in. thick, punched full size. (213)–Other material up to ¾ in.; sub-punched and reamed; (214)–Over ¾ in., drilled. (230)–Field connections, exc. bracing, assembled and drilled or reamed or use metal templet.	(118)–Material over ¾ in. thick, sub-punched and reamed or drilled. (135)–Floor connections, sub-punched, reamed to 1 in. steel templet.	(72)–Subpunch and ream: Tension members except bracing; floor and connections; plate girder flanges; main comp. members. (78)–Abutting joints comp. members turned or planed, ex. flanges of girders which must be fully spliced. (93)–Spliced members assembled and reamed in place; floor connections, to 1 in. steel templet.	(28)–Soft steel up to ¾ in., punched; over ¾ in. sub-punched and reamed. (31)–Abutting faces comp. members faced and forced into contact, holes reamed in place. (37)–Field connections, except bracing, assembled and reamed or use 1-in. iron templet.	(200)–Bracing, etc., up to ¾ in thick, punched; other material up to ¾ in., sub-punched and reamed; over ¾ in., drilled. (213)–Abutting joints tension and comp. members, girder flanges and web, faced. (211)–Field connections, exc. bracing, assembled and drilled or reamed, or use metal templet.
(246)–Floor girders faced at ends, min. 1/16 in. from connection Ls.	(129)–Floor girders faced at ends, min. 3/32 in. from connection Ls.	(94)–Floor girders faced at ends, min. 1/16 in. at root of Ls.	(36)–Same as (94), preceding col.	(214)–Floor girders faced at ends, min. ¼ in. from connection Ls.
Open Hearth Structural Steel				
(162)–Max. P–acid 0.06%, basic 0.04%; max. S. 0.05%; tension, 55,000 to 65,000; min. yield point 50% tension; min. elongation in 8 in., 1,500,000/tension; in 2 in., 22%. (170)–Bend cold around pins as follows: Thickness t — Diam. d Up to ¾ in. — flat ¾ to 1¼ in. — t Over 1¼ in. — $2t$	(86)–Max. P.—acid, 0.06%, basic 0.04%; max. S, 0.05% tension 60,000 (±5,000); min. elong. in 8 in. 1,500,000/tension; in 2 in. 22%. Bend cold 180° flat. (99)–Ls ¾ in. thick or less, open flat; ½ in. or less, bend shut cold when required by inspector.	(11)–(Medium steel) max. P—acid, 0.08% basic 0.04%; max. S. 0.05%; tension, 60,000 to 68,000; min. elastic limit, 33,000; min. elong. in 8 in., 22%; min. reduction of area, 37%. (12)–Bend cold flat if ¾ in. thick or less.	(1)–Soft steel in general, medium steel for pins, rollers, etc.; max. P.—acid 0.06%, basic 0.04%. (13)–Pin steel—tension 60,000 to 70,000; min. elastic limit, 33,000; min. elong. in 8 in., 17%; min. reduction of area, 40%. Soft steel—tension 55 to 65,000; min. elastic limit, 28,000; min. elong. in 8 in., 25%; min. reduction in area, 50%. (11)–Bend cold 180° on itself. (12)–Drifting test; ½ in. hole 1¼ in. from edge, enlarge 50%.	(164)–Max. P.—acid 0.06%, basic 0.04%; max. S. 0.05%; tension 56,000 to 64,000; min. yield point, 33,000; min. elong. in 8 in.—25%; in 2 in., 22%; min. reduction of area, 50%.
Open Hearth Rivet Steel				
(162)–Max. P, acid or basic 0.04%; max. S. 0.045%; tension 46 to 56,000; min. yield point, 50% tension; min. elong. in 8 in., 1,500,000 tension. (173)–Bend cold 180° flat.	(86)–Max. P—acid or basic 0.04%; max. S, 0.04%; tension, 50,000 desired; min. elong. in 8 in., 1,500,000/tension. Bend cold 180° flat. (100)–Nicked, bend cold around $d = t$; gradual break, fine silky uniform fracture.	(11)–Max. P—acid 0.08%, basic 0.04%; max. S. 0.05%; tension 46 to 54,000; min. elastic limit, 26,000; min. elong. in 8 in., 26%. (12)–Same as 100, A. R. E. A., 1910. (102)–Completed bridge tested by train 60 mi. per hr.; min. deflection 1/1500 span; return to original camber.	(13)–Tension, 48 to 56,000; min. elastic limit, 28,000; min. elong. in 8 in., 28%; min. reduction of area, 56%. (11)–Bend cold around its own thickness.	(164)–Max. P.—acid or basic 0.04%; max. S. 0.04%; tension, 46,000 to 54,000; min yield point, 28,000; min. elong. in 8 in. 30%; min. reduction of area, 55%.

tions to be assembled before reaming or else reamed to metal templet; this operates to extend the practice of yard assembly of trusses.

Precedent, or tradition, appears to be a factor in the clauses governing proportioning materials for reversed stress. Additional material is required in such members by all of the specifications, apparently as a concession to former ideas on fatigue. The increase specified varies from 50% of the smaller stress to 80%. Three of the specifications require that the end connections of such members must be proportioned for a larger stress than the members themselves, apparently mistrusting the resistance of riveted joints to "fatigue" action.

Tendencies of Change

Important tendencies of recent years are represented in the clauses governing impact, secondary stress and provision for future increase of load.

Impact is not mentioned in the "min-max" specifications. The Schneider impact formula $300/(300 + L)$, devised years ago as a substitute for varying the unit stress or increasing the live load according to the range of stress, found a place in the Old A. R. E. A. specification, while in the New York Central and the Proposed A. R. E. A. the new formula, $30{,}000/(30{,}000 + L')$, written by Prof. F. E. Turneaure from the results of his series of impact measurements on bridges, is adopted.

Secondary stresses are not mentioned in the older specifications nor in the Pennsylvania specification. The New York Central and the Proposed A. R. E. A. require secondary stresses to be computed, but call for additional material only when the secondary exceeds 33%. The Proposed A. R. E. A. words its requirement in such a way as virtually to waive the secondary stress computation except when members are wider than one-tenth their length or when trusses are subpaneled.

Load probabilities are taken account of in two of the specifications. The New York Central and the Proposed A. R. E. A. provide that bridges carrying several tracks need not be designed for full live load in the worst position simultaneously on all tracks, but reduce the live load by 5% for each track over the first. The probability of future increase of loading is met in the Proposed A. R. E. A. specification by increasing the material in the web members, where only two-thirds of the dead load and 1½ times the live load and impact are to be considered acting. In the Pennsylvania R.R. specification a 100% increase of live load is to be considered, with unit stress increased 100 per cent.

A final load test of the completed bridge is provided for in the Southern Pacific specification, in which the deflection under this load is limited to 1/1500 span. The weight of the test train is not fixed, but it is to be run at 60 miles per hour. This test is rarely carried out.

That bridge specifications are still far from approaching a condition of standardization is indicated not only by the variations above noted, but also by the fact that some clauses are so phrased as to require interpretation. Thus, it is specified that centrifugal force is to be regarded as live load; this cannot mean that it is to be considered as a moving load, since the fact that centrifugal force accompanies the movement of a train is sufficient to show that partial loading must be taken into account. The clause may mean that impact must be added to the static centrifugal effect, but the word impact is not mentioned in the clause. Again, a clause calling for certain increase of opposing stresses requires the end connections to be proportioned for the sum of "the stresses so increased," and leaves a doubt as to whether the stresses before being increased or after being increased are to be added.

New Department of Health for Canada

A DOMINION or Federal department of health for Canada is provided for by a recent act of Parliament. The department will be headed by a crown minister, and there will also be a deputy minister of health, both appointed by the Governor in council. No specific provision is made for an engineering or other technical bureau or service, but the act authorizes the employment of such staff as may be "necessary for the proper conduct of the business of the department." The department is to have charge of "all matters and questions relating to the promotion or preservation of the health of the people of Canada over which Parliament itself has jurisdiction." Without "restricting the generality of the foregoing" authorization, the act mentions particularly the following matters which will be under the jurisdiction of the department:

1. Coöperation with the provincial, territorial, and other health authorities with a view to the coördination of the efforts proposed or made for preserving and improving the public health and the promotion of child welfare.
2. The establishment and maintenance of a national laboratory for public health and research work.
3. The inspection and medical care of immigrants and seamen, and the administration of marine hospitals.
4. The supervision, as regards the public health, of railways, boats, ships and all methods of transportation.
5. The supervision of Federal public buildings and offices with a view to conserving and promoting the health of the civil servants and other Government employees therein.
6. The enforcement of any rules or regulations made by the International Joint Commission, promulgated pursuant to the treaty between the United States of America and His Majesty relating to boundary waters and questions arising between the United States of America and Canada, so far as the same relate to public health.
7. The administration of the statutes mentioned in the schedule to this act, and of acts amending the same, and also of all orders and regulations passed or made under any of the said acts; and all the duties and powers of any minister of the crown under either of the said acts or any of the said orders or regulations, are hereby transferred to and conferred upon the Minister of Health.
8. Subject to the provisions of The Statistics Act, the collection, publication and distribution of information relating to the public health, improved sanitation, and the social and industrial conditions affecting the health and lives of the people.
9. Such other matters as may be referred to the department by the Governor in council.

Power to make such regulations as may be needed to carry out the provisions of the act, and to impose penalties for violations of any such regulations, is vested in the Governor in council.

Provision is made for a Dominion council of health to include the deputy minister of health, who is to be chairman, and also the chief executive officer of each provincial board of health in the Dominion, together with not over five other persons to be appointed by the Governor in council. This Dominion council is to meet at such times as the Minister of Health may direct and is to have such duties and powers as may be prescribed by the Governor in council.

The act specifically excludes the minister or any officer of the Dominion department of health from exercising control over any provincial or municipal board of health operating under the laws of any province.

Among the statutes mentioned under (7) in the schedule to the act are acts relating to quarantine, adulteration and the Public Works Health Act as given in the revised statutes of Canada of 1906.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Status of Public-Works Engineers Should Be Changed

Sir—*Enginering News-Record* could do the public a service, and relieve an important class of engineers from humiliating restrictions, by exerting its influence to bring about a change in the relations of city and county engineers to the matter of the selection of pavements for streets and highways.

Existing conditions make for great wastefulness of money expended for road improvements. Even the poorest types of hard surfacings are high in cost. Mistakes in selection often entail the squandering of huge sums of money. This is inevitable so long as ignorance or prejudice or commercial interests dominate the councils of the selective body. It is obvious that sound public policy demands intelligent judgment in matters involving the expenditure of public funds raised by taxation, or assessed against property. An engineer is best qualified to pass intelligent judgment upon all matters in his department.

A city solicitor is regarded as authority on all legal questions, and a health physician's dictum has all the effect of an authoritative decision in the domain of public health. These officials are consulted as experts, and their opinions are accepted and acted upon *nem con.*

A city or county engineer also is—or at least he ought to be—an expert. His trained judgment and technical knowledge ought to have preponderating weight in all affairs pertaining to the engineering field; yet the engineer is not clothed with authority, and in very many cases his expert opinion is disregarded, or it is not asked at all, when choice of the type of street or highway pavement is to be made. In other words, the engineer is not allowed to exercise his higher functions as an expert, but is confined to surveying, designing and drafting, the mere routine drudgery of office, while others, far less qualified than he, assume to pass expert judgment. This is an injustice to the qualified engineer, and it is prejudicial to public interest.

Law and custom are jointly responsible for a condition which is irksome to self-respecting engineers, and which places important and costly public improvements at the mercy of ignorance, caprice or penuriousness.

Circumstances often compel an engineer to design and supervise the construction of a type of pavement which his judgment disapproves; but no circumstances ought to deter him in such case from filing a protest in behalf of the taxpaying public and for the protection of his own reputation. Professional ethics and official duty require that an engineer guard his employer-public against errors of judgment and the futility of false economy, if possible. Engineers as a class would do that if they could do it; but they are not allowed to do it, and they have fallen into the habit of letting such things go by default.

These matters are in the hands of laymen and property owners who have very limited opportunities for informing themselves concerning the relative merits of types of pavements, and no knowledge of the action of materials under traffic stresses and weather influences. The nature and influence of soils as factors in road improvements have no meaning to the average property owner, nor is it possible for him to analyze a traffic census in terms of effect upon pavements, nor can he calculate with any degree of accuracy the probable growth of traffic in volume, weight and kind that a road may be called upon to sustain, or could sustain.

The engineer is supposed to be, and he ought to be, qualified on all these points. Hundreds of miles of pavements of various kinds have gone to pieces under modern traffic. The engineer knows why, but the average person does not know. The engineer knows what kind of road surfacing will pit, ravel or disintegrate under the combined influence of traffic and the elements. He knows what materials are proof against all these influences. He knows what form of construction is best, and in a professional way he has acquired knowledge of many other important facts which are unknown to the layman. He may advise, if asked so to do, but he cannot decide finally.

Subordination of engineering judgment to the caprice of chance is deplored by all who are familiar with the situation all over the country. A peculiar feature of the situation is that pavements are the only thing, of consequence, subject to this loose method of determination. The choice of grades, width and kind of sidewalks to be laid is not left to property owners. The city authorities decide all these questions autocratically. So also with sewers and other public improvements. Holding a referendum of owners of property abutting a street or road to be improved is folly. All the taxpayers in a city join in paying for the paving of street intersections, and all are called upon to replace the entire pavement when it has worn out.

In the interest of ultimate economy the city engineer ought to be allowed to decide what kind of pavement should be laid. If a reservoir is to be constructed, property owners are not expected to dictate the kind of material that shall be used; but streets and roads, which are the most expensive of all ordinary public improvements, are taken out of the hands of experts, and the selection may be influenced by any consideration except adaptability and durability. As a result, ultimate good is often sacrificed to a false initial economy.

Every step in the selection, the design and the construction of a street or road presents an engineering problem, and nobody not an engineer is competent to solve these problems in advance.

They do things better abroad. Over there engineers decide where a road shall run, what kind of pavement shall be put down, and how wide it shall be. That system produces uniform results and gives the most satisfactory road service. America is still too near the demagogic era of new countries. Public officials too often

try to curry favor with the voters rather than act with public benefit solely in view.

The laws in many states must be revised, and it may be necessary to change the method of choosing city and county engineers, before reform can be accomplished. The engineer must receive some real authority and be held personally responsible for his exercise of authority. The practice of letting anybody or everybody except an engineer exercise either legal or delegated authority in the matter of selecting types of roads to be built ought to be discontinued, and I hope that *Engineering News-Record* will aid in revolutionizing present practices in that regard.

F. A. CHURCHILL.

Conneaut, Ohio.

Are Highway Terminals Necessary?

Sir—The lack of proper terminal facilities of our large cities is a subject which too many highway enthusiasts seem to forget. In Chicago we are spending millions to make presentable our front yard, Michigan Ave., but only dilatory steps are being taken to relieve the congestion of the produce markets on S. Water St., or to provide a proper center or centers for the cheap handling of vast amounts of farm produce that comes into the city for its own consumption. The present high cost of food is largely attributable to terminal charges. City officials some time ago turned down the plan of the Santa Fé R.R. for a fruit and produce terminal, after that road had brought it to a point of practicability by acquiring the necessary land. Plans have been proposed for an underground storage and market in Grant Park, and others for taking the commission-house business out of the downtown district. Feeble efforts, from time to time, have been made to establish municipal markets in various parts of the city. A very few are now in operation, but the city officials have given them scant support.

Secretary Lane and those who are advocating the reclamation of a large additional acreage of arid and swamp lands do not tell us how the farmer is to be reimbursed for his efforts, which he surely will not be if the present high terminal costs are not materially reduced. Considering terminal and transportation facilities for certain perishables, we have more land under cultivation than we can take care of. At least one-third of the 1918 Middle West fruit crop was not shipped. And many a fruit farmer has found that freight-terminal and commission charges, on top of the cost of crating and picking, too often leave him with a deficit or a meager return on his labor and investment.

When the development of highways is considered, with the inevitable added congestion of produce easily transported, the terminal problem should not be lost sight of. Perhaps the solution lies in large, centrally located highway terminals or in many small ones strategically scattered over the city near population centers. This would reduce street congestion from the present "back hauling" from market to points of consumption.

Chicago, Ill. C. H. NORWOOD

Springs Found in Standpipe

Sir—The above caption suggests that there must have been a special dispensation of Providence in favor of a small municipality which has been suffering from deficient water-supply for some time. The local superintendent feels that if there was any dispensation it came from the other fellow. Unfortunately, and as much as they might have been desired, the springs found in the standpipe, (and they were numerous) were not springs of water but were pump-valve springs.

The water-supply was derived from shallow wells. The pumps, which are old, have been heavily overloaded, and pump valve springs and rubber valves have not infrequently been drawn in through the suction, and as there was no fish-trap or strainer on the delivery from the pumps, they are pumped along with the water into the distribution system.

The trouble is a serious one, as the valves and springs have lodged in valves and hydrants along the course of the distribution mains, excepting such as have been forced clear through the system into the standpipe. Where these valves or springs lodge in valves or hydrants it is often impossible to close the valves in case of breakage in the mains, and if a hydrant is opened it is often impossible to close it. The trouble has become so serious that the question of some practical method of removing these obstructions has arisen.

Of course, remedies will be applied to prevent further occurrences of this kind, but the difficult problem is to get these obstructions out of the distribution system with the least trouble and interference with the water-supply. The present superintendent, whose attention was called to this matter by inability to close off districts in the city for repairs of pipes soon after he took his position, believes that the trouble had been going on for many years and that there may be some hundreds of old pump valves and valve springs scattered through the mains.

Possibly some other water-works engineers may have had similar trouble and can suggest the remedy.

HYDRAULIC.

Large Construction Firms Shun Road Work

Sir—I have read with interest the article in *Engineering News-Record* of June 12, 1919, p. 1150, by C. S. Hill, associate editor, entitled, "Large Construction Companies Shun Road Work." My experience has shown me that Mr. Hill has stated the case fairly—if anything, he has made the case too mild.

Among other reasons for this condition, Mr. Hill states, "too great stress has been laid upon the possibilities of dishonesty." With this I fully agree. My own practice has been in the Middle States and the South, principally, and I have experienced many "ups and downs" in my position as referee between county commissioners and contractors.

Ninety per cent. of the county commissioners are men who know little of business in general, and less of road matters. These men let contracts, hire engineers and their assistants, pass orders directing the work or directing the engineer how to direct the work, pass plans and surveys, pay accounts or prune them as they see fit and act as a rule wholly on their sentiments or their prejudices. I have seen good contractors refused jobs solely because a local man wanted to have a try at road-building. I have seen other instances where a crooked contractor has been awarded a job by holding out sufficient inducement to the commissioners.

My stand has always been that an inexperienced man should not be given a contract, though he makes the low bid. Most of the cases I have observed have proved

that the low bid of an inexperienced contractor is unsatisfactory in the end, resulting in delays, bad work, misunderstandings and bad feeling.

The time has arrived when the character of every contractor bidding on work should be investigated, and, if he has a good clean record, does good work and is properly equipped, he should be treated fairly. If his record will not stand the spotlight, or his experience isn't equal to the anticipated demands, he should not be given the work. By securing men of high character, you secure good work, promote good feeling and all goes harmoniously. The way to keep out of trouble is to block it, before starting forth on any undertaking.

The contractor and the engineer should be equally interested in securing good work, and should have no hesitancy in consulting each other about any phase of it. Honest men and right intentions on both sides will work to the advantage of all concerned.

Another reason is well stated by Mr. Hill: "Too many road departments have attained a reputation for breaking contractors."

My observation has been that state and Federal engineers frequently are to blame for high bids being submitted, as their "red tape" and technical supervision make low bids impossible. The contractor, not knowing what to expect, must anticipate the worst, and bids accordingly. A PRACTICAL ENGINEER.

Highway-Engineer Work in France

Sir—You have had several good articles in your paper relative to the keeping of the engineering forces in France, and I am inclosing herewith a circular issued Mar. 20, 1919, which is a compilation of all road instructions given to the engineering troops printed by the Mobile Topographical Unit, 29th Engineers.

If France is not getting any more service out of our troops than this circular indicates, it is high time they were moved on where they can be furnished with more suitable tools than the mud hoe, shovel and pick. There is a shortage in this country not only of labor but of intelligent oversight in our road work, and it seems too bad that the quality which we have in our engineering troops in France is expended where it is deemed cheaper to break rock by hand than by crusher. You, perhaps, have seen this sheet of instructions before, but if not and you think it advisable, I should like to see the instructions printed in *Engineering News-Record*, in order that the engineers of this country may be advised of the manner in which our engineers are being worked in France. CON M. BUCK.

Topeka, Kan.

[Some of the chief points to which Mr. Buck calls attention are reproduced below.—EDITOR.]

All roads in continued use by the American Expeditionary Forces will be maintained and kept in repair by our forces. Since the enormous mileage involved and the scarcity of road machinery make it impracticable to do extensive resurfacing with machinery, the work will be done by hand, with simple hand tools improvised if they cannot be otherwise obtained.

The economic value of the work to be done is not the business of officers who have received instructions what to do. However, what is being done is the highest economy. Men are in France in abundance. The cheapest way to maintain roads is by using labor to replace, continually, worn-out soft rock. It is cheaper to break rock by hand than by crushers, as men have to be maintained anyway. There is slight chance of any engineer or labor personnel being sent to the United States until roads in use by American troops are in good condition.

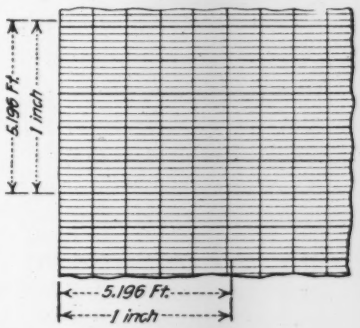
In the maintenance of the first-class roads the chief tools necessary are the mud hoe, shovel, pick and roller, and their importance is in the order named.

It is expected that available materials will be used and that soft rock or any other kind of rock will be placed in holes as fast as it goes out, even if a man replaces it after each vehicle passes.

The road detachments and the officers supervising them should consider this work most excellent training and should see that valuable knowledge and training are obtained on this important engineering work.

Computing Cross-Section Paper for Earthwork Computations

Sir—Your attention is called to the inclosed sheet of "Computing Cross-Section Paper," with instructions [small section reproduced, actual size]. The use of this paper saves the time ordinarily spent in reducing square inches to square feet and cubic feet to cubic yards, as required with other cross-section paper.



Perhaps those of your readers who use the planimeter for measuring end areas for earthwork computation will be interested. I designed this size and scale for highway work with 100-ft. stations. The same principle may be employed for other requirements. The computing cross-section paper is ruled to a scale of 1 in. $= \sqrt{27}$ ft. $= 5.196$.

If the cross-sections are plotted so that the smallest horizontal and vertical divisions on the paper represent 1 ft. and 0.2 ft., respectively, the scale of the paper is such that 1 sq.in. will represent 27 sq.ft., so that the planimeter reading in square inches will give the cubic yards per linear foot of cut or fill.

The results may be tabulated most conveniently by a method which employs average end areas formula, as described on p. 787 of your issue of Apr. 17.

J. H. DORROH,
Professor of Civil Engineering, University of Mississippi.
University, Miss.

Heavy Decline in Typhoid Since 1900

Typhoid deaths in the registration area of the United States in 1917, according to the Census Bureau's belated summary of mortality statistics for that year, totaled 10,113 in a population estimated at 75,000,000 distributed in 27 states, the District of Columbia and 43 registration cities in nonregistration states. This gives a rate of 13.4 deaths per 100,000 population, compared with 35.9 in 1900. The typhoid deaths in 1917 were 0.9% of all the deaths recorded.

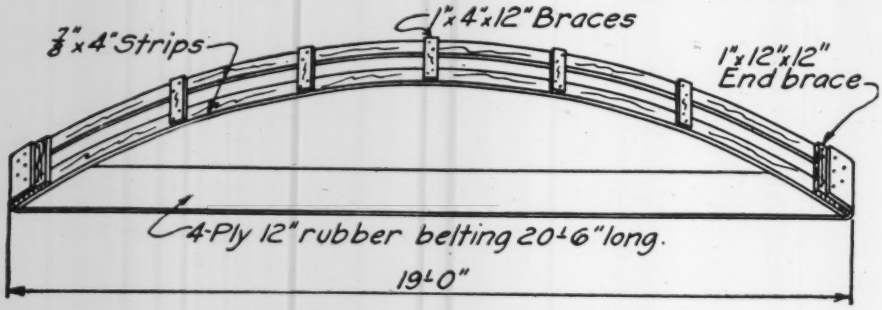
HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Bow-Frame Belt Used in Finishing Concrete Roads

ONE of the more recent adaptations of the belt for finishing concrete roads is shown in the accompanying illustration. This device enables the workmen to push as well as pull when operating the belt, thus attaining greater efficiency.

The bow, which is made of light material, serves to keep the belt taut, and thus, it is claimed, gives a more



BOW-FRAME KEEPS CONCRETE FINISHING BELT TAUT.

even surface finish. It was described in a recent issue of the *Highway Magazine*.

Another method of attaining pressure of the belt on the surface, which has been used, is to weight it with short blocks of wood.

Doing Hardest Work by Force Account Keeps Ruling Prices Down

BY ALBERT S. FRY
Morgan Engineering Co., Memphis, Tenn.

RULING prices for land clearing are kept from rising, in the work being done in the Inter-River Drainage District, Missouri, by substituting force-account for contract work, on the most difficult portions. Clearing the right-of-way for the levees in such places

CYPRESS BRAKES COSTLY TO CLEAR FOR LINES

as the cypress brakes and sloughs shown in the illustration is much more difficult than the general run of clearing, and would tend to raise the prevailing prices. To prevent this a policy has been adopted to do all the difficult work with the district's forces and to let contracts for the other work. Thus, the prices for which the ordinary work can be let are kept from rising as a result of the higher cost of doing the work on the brakes and sloughs.

Ordinary land is cleared by contract for $30 an acre. If some of the cypress-brake work was let by contract at double this price, the effect would be to raise the price for ordinary clearing by several dollars.

Other Articles in This Issue of Interest to Contractors

Special Design Features and Rapid Erection of 540-Foot Suspension Bridge Page 4
Shipbuilding Equipment and Methods at Fore River—I. Hull Construction Plant Page 19
Large Construction Firms Shun Road Work (Letter) Page 38

Concrete Materials Chuted Into Sidewalk-Vault Mixing Plants

GRAVITY delivery of concrete materials by chuting to mixers situated in sidewalk vaults, whence it is distributed by cars to the cylinder piers, is the method employed in concreting the foundations for the headhouse of the new union station in Chicago. The site, covering an entire city block, was excavated to the basement level, which served as a working floor in sinking the open pier wells. Two concrete mixers were installed on opposite sides of the site, and about midway between the street and basement levels. This makes it possible to handle materials with little or no obstruction of street traffic, as in cases where it is necessary to carry in the materials at the sidewalk level.

Stone and sand are dumped in piles along the curb line, and cement in sacks is stored in a shed in the street, the sidewalks and main parts of the roadways being kept clear. The materials are wheeled to openings in the roadway, near the gutter, and chuted to the mixer below. Concrete is discharged directly into steel dump cars which are moved on portable narrow-gage tracks to the wells and there dumped. Tracks are laid in both directions across the site, with turntables at their intersections, allowing the cars to be run to any pier desired.

Wood lagging and steel ring braces for the wells are also lowered to the site through similar openings in the street. The John Griffith & Son Co. has the contract.

NEWS OF THE WEEK

New York, July 3, 1919

Bills for Department of Public Works

Government Engineering To Be Centered in Department To Take Place of Interior

Identical bills have been introduced in the Senate by Mr. Jones of Washington and in the House of Representatives by Mr. Reavis of Nebraska, providing for a Federal Department of Public Works to take the place of the present Department of the Interior and to have charge of all of the engineering activities of the United States Government. Such bureaus of the Interior Department as are not engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the new Department of Public Works.

The new department would include the Supervising Architect's office of the Treasury, the Construction Division, River and Harbor Improvements, the Mississippi River Commission, and California Debris Commission of the War Department, the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce, the Bureau of Public Roads, and the Forest Service of the Department of Agriculture. At the same time the Patent Office is removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Treasury Department and the Bureau of Education to the Labor Department. The Bureau of Indian Affairs is transferred to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works. Other minor branches of the Interior Department go under different cabinet offices.

The bill provides that the new Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the department and to evaluate the technical principles and operations involved in the work thereof." Four assistant secretaries, each to be paid $7500 per annum, are provided. One of these is to have jurisdiction over matters of engineering, design and construction; another over architectural design and construction; a third over all scientific work and surveys, while the fourth is to be in charge of land and naval matters.

The bill provides that engineer

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Properties and Design of Concrete Discussed

Annual Convention of American Concrete Institute Develops Some Important New Facts Regarding the Material

War activities during the past year prevented many of the committees of the American Concrete Institute from continuing their work in the preparation of specifications for concrete and its products, so the major part of the annual convention held at Atlantic City on June 27 and 28 was devoted to papers which, it happened, emphasized the properties and the design of the material. Several of these marked notable steps forward in the knowledge of the material, and all—together with the concrete papers presented to the American Society for Testing Materials in the joint session of the two societies on June 27—were valuable.

Committee Reports

In spite of the other interests of the past year some of the committees presented reports. Three of them submitted standards for the letter ballot of the Institute. These were the Standard Specifications for the Manufacture of Concrete Roofing Tile, by the Committee on Building Block and Cement Products, hereafter to be known as the Committee on Concrete Products; some minor revisions in the specifications for concrete sidewalks and for concrete floors, by the Committee on Sidewalks and Floors, and revised Recommended Practice on Portland Cement Stucco, to supersede the present Standard Specification on the same subject by the Committee on Concrete Surfaces. The Committee on Concrete Sewers submitteed for the second time a Specification for Monolithic Concrete Sewers and added thereto Specifications for Reinforced-Concrete Pipe Sewers. For a second time the convention returned the specifications to the committee for revision. The opposition this year centered mainly on the fact that the specification contained too many pure contract provisions, although there was decided opposition to the elimination of limestone as an aggregate.

The recommended practice for stucco is particularly to be commended. There has been a specification for this subject but it was not satisfactory to the committee, which is headed by J. C. Pearson of the Bureau of Standards. This year the committee made a complete revision, and accompanied the formal specification with running comments so that the whole makes the most complete compendium of this subject of stucco ever issued.

The Committee on Fireproofing summarized the results of recent tests on the fire resistance of concrete columns, including the paper by W. A. Hull, at the present and at last year's convention, describing tests at the Bureau of Standards, and other actual conflagration tests. The results, which strongly condemn gravel aggregate for fire resistance, will be summarized in a future issue. The Committee on Nomenclature submitted some definitions and that on Roads and Pavements some revisions of the recommended practice which took 50 pages of last year's Proceedings of the Institute. As these revisions were not submitted to the membership before the convention, they will not go to letter ballot but are to be printed for reference and possible action next year. They relate mainly to consistency and surface finish. The Committee on Reinforced-Concrete Highway Bridges and Culverts, under the new chairmanship of A. B. Cohen of the Lackawanna Railroad, has embarked on an ambitious program toward the preparation of standard specifications for concrete highway bridges. This contemplates recommended practice on details of design, assumptions in design, general specification of materials and performance of work and methods of construction, the latter to be revised from year to year with new developments. As outlined in the report of the chairman, the work of the committee, promises to furnish a much needed addition to engineering literature.

Building Laws Report

Two years ago the Committee on Reinforced Concrete and Building Laws presented some proposed Standard Building Regulations for the Use of Reinforced Concrete, which in some respects, went counter or differed from the provisions of the then new "final" report of the Joint Committee on Concrete and Reinforced Concrete, of which the American Concrete Institute is a member. The A. C. I. committee this year brought in a revision of these building regulations, but they had not been fully considered by all of the committee and were therefore ordered printed as information. It might be said that while a number of the provisions of the Joint Committee are incorporated in these new regulations there are still many points of divergence, particularly in the sections on columns and flat slabs, the regulations as a rule being more liberal in design.

This feature was criticized by several members on the floor.

Papers on concrete properties included "Effect of Vibration, Jigging and Pressure on the Strength of Concrete," by Prof. Duff A. Abrams; "Test of Concrete Tanks for Oil Storage," by J. C. Pearson and G. A. Smith; "Fire Tests of Concrete Columns," by W. A. Hull, and "Structural Laboratory Investigations in Reinforced Concrete Made by Concrete Ship Section, E. F. C.," by W. A. Slater. The first two are abstracted on page 16; both give definite new data on concrete. The matter on the vibration of concrete is particularly useful in pointing out that the value of methods of agitation lies mostly in the distribution of the concrete in the form, except with dry concrete in which they seem to increase the efficiency of the water, and therefore strengthen the concrete.

Professor Slater's investigations cover the wide range of studies required for the concrete ship work of the government, and while devoted to that specialized subject are nevertheless widely applicable to all types of reinforced-concrete work. The subjects covered are corrosion of reinforcement, bond tests of coated bars, bond tests with lapped bars, reversal of stress, impact on thin shells, effect of brackets, and web reinforcement.

Light-Weight Aggregate for Building Construction Discussed

Design of concrete structures was treated in several papers. One by A. W. Stephens, of the Turner Construction Co., was an analytical investigation into the economics of light-weight aggregate for building construction. The results were somewhat disappointing to those who have anticipated a possible development of this material on account of the reduction in dead load and consequent saving in material. Mr. Stephens found in a typical six-story building the saving of a 99-lb. aggregate over a 145-lb. of the same strength to be only about 10%, which is far below any present or prospective relative cost of the materials. This low value is apparently due to the fact that the sizes of floors are largely dependent on factors other than load, so that savings must come mostly in the columns and footings. A higher building, of course, would show greater saving.

H. B. Andrews, consulting engineer of Springfield, Mass., read a paper on "The Design of Reinforced Concrete Fuel Oil Reservoirs," with a supplementary paper by J. W. Lord of Boston Manufacturers Mutual Fire Insurance Co., on fire hazards in such tanks, both of which summarize adequately the present status of what is a development of the war, the extensive storage of fuel oil near industrial plants in concrete tanks or reservoirs.

A final paper on design was one on "The Design of Concrete Ships" by J. Glaettli, Jr., of the Concrete Ship Section, which summarized the knowledge gained by the Government in the strenuous year in which it was designing this new type of marine structure. A. L. Bush, of the same office, read a paper describing the layout of the five big concrete yards, with special attention to the reasons for the use of side launching in these yards. Concrete ship development was rounded out by an illustrated talk by J. E. Freeman, of the Portland Cement Association, on such craft in this country outside of the Emergency Fleet Corporation, and the developments in foreign countries. S. C. Hollister, also of the Concrete Ship Section, described the methods of construction of the concrete barges for the New York State Barge Canal, which, as told in *Engineering News-Record*, Feb. 6, 1919, were built in four different yards. F. R. McMillan's paper on the strainagraph, and a paper by A. C. Irvin, on "Concrete Railway Track Support," completed the list of papers.

Presentation of Medals

A pleasant interlude in the technical proceedings was the award of four medals. One of these was a special medal struck off for the Institute and awarded to W. Leslie Comyn, of San Francisco, Calif., for, to quote the medal itself, "his faith and courage in building the first American ocean-going concrete steamship," the "Faith." The others were the Wason medals, the gift of Past President Leonard C. Wason, of Boston, for the most meritorious paper presented to the Institute in the year. On account of the war, the award has never been made, so three were awarded this year: For 1916, to Prof. A. B. McDaniel, for his paper, "The Effect of Temperature on the Strength of Concrete"; for 1917, to Maj. Charles W. Gow, for his paper, "The History and Present Status of the Concrete Pile Industry," and for 1918, to Prof. Duff A. Abrams, for his paper, "Effect of Time of Mixing on the Strength and Wear of Concrete."

Practically the same officers have been continued for the ensuing year, with Prof. W. K. Hatt, of Purdue University, as president. It was announced that next February the Institute would return to its regular practice, broken during the war, of holding its convention in the winter, and would meet in Chicago.

Sacramento Votes $1,800,000 for Filtered Water

More than the necessary two-thirds majority of votes for $1,800,000 of bonds to provide filtered water from the Sacramento River were cast at the election held at Sacramento, Calif., June 26. Editorial comment on the long delays in settling the water-supply question at Sacramento appeared in *Engineering News-Record*, June 5, 1919, p. 1091. Following the favorable vote it was announced that an 18-story business block which has been under consideration for some time would be commenced at once.

Southwestern Not to Join American Water Works Association

Important actions taken at the convention of the Southwestern Water Works Association held in Kansas City, Mo., June 23-26, include a decision not to accept the invitation of the American Water Works Association to affiliate with the latter and a decision to publish a monthly journal. The territory of the association was enlarged to take in Nebraska, and the name changed to the South-West Water Works Association, the hyphen indicating that the organization proposes to serve the South and the West—Mississippi, Colorado and one or two other states are under contemplation as prospective territory. Objections raised to joining the national organization were that such affiliation would eliminate the local secretary, would return only 25% of the fees collected and that the journal was practically the only tangible return the majority of the members would receive for the 75% retained. The value of the prestige and advantages of a nation-wide association in presenting a solid unit with once voice on national problems was upheld by H. V. Knouse, of Omaha, but he was alone in the debate and voting.

Two issues of the journal have been circulated already among the members and prospects in the territory, sufficient advertising having been obtained to more than defray the cost, $245. The subscription price is $2 a year. A committee was appointed to arrange terms with R. O. Gresham, Temple, Texas, a newspaper editor, as editor and publisher. The secretary of the association was voted $150 in addition to his regular $300 salary to act as business manager. The financial report showed a balance of $27 at the end of the fiscal year, April 1, with $250 due the secretary.

W. L. Benham presented an illustrated talk on the "Operation of the Camp Funston Utilities," together with a description of a manual of operation finally adopted as standard for all of the camps under the Maintenance and Repair Division. In the discussion of meters as detectors of waste, J. Smith, of Emporia, Kan., described a home-made clock device applicable to household meters which would make a continuous record of the consumption. In a round-table discussion of the question "At What Charge Per Month Can a ¾-in. Meter Be Installed and Maintained When Owned by the City?" J. F. Anderson, who has kept meter records in Kansas City for 26 years, stated that the cost of setting varied from 50c. to $7.50, and the annual maintenance from 3c. to $2.50 annually. No more definite statement was made.

Leon I. Kahn, Shreveport, La., was elected as president and E. L. Fulkerson, Waco, Tex., as secretary. New Orleans gets the 1920 convention and the time is changed to October instead of June or July.

Motor Transport Corps To Make Ocean to Ocean Trip

An ocean to ocean trip is being planned by the Motor Transport Corps of the United States Army for the fourfold purpose of: (1) Giving an extended service and performance test of the various standardized types of army motor equipment; (2) to collect detailed data for use in connection with the technical training of the personnel of the corps; (3) to demonstrate the practicability of long distance motor commercial transportation and the consequent necessity for the expenditure of governmental appropriation for highways, and (4) to provide an opportunity for procuring recruits for the Motor Transport Service.

Two complete truck companies, of war strength, consisting of a total of 42 army trucks, including all of the standard makes used by the government during the war, will participate, accompanied by motor cycles, ambulances, tank-trucks, mobile steel kitchens, mobile repair shops and signal corps searchlight trucks, and a personnel of 209 army officers and men. The start will be made from Washington on July 7, proceeding by way of Frederick, Md., to Gettysburg, Pa., from which point the Lincoln Highway will be followed to San Francisco. It is planned that the convoy will reach the Presidio at San Francisco about Sept. 1.

Chicago to Liverpool by Steamer

A direct voyage from Chicago to Liverpool by the Great Lakes, the St. Lawrence River and the Atlantic Ocean was started June 26, when the steamship "Lake Granby" sailed from the Chicago River. This is one of the steamers built in Chicago for the U. S. Shipping Board, and its cargo consisted largely of Chicago products. Two boats built at Duluth are to take cargoes at Chicago for a similar voyage. Several years ago two steamers were sent from Chicago to European ports, but it is understood that the aggregate charges and delays incident to the passage to the ocean were so great that the venture was not successful commercially and was abandoned after the first voyage. Under present conditions the through water rate is said to be materially lower than the combined rail and water rate.

Department of Public Works

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officers of the United States Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new departments for not over two years, and members of the Corps of Engineers may under the direction of the Secretary of Public Works be detailed by the Secretary of War to temporary duty in the new department for such instruction, training and experience as may be desired.

Engineering Educators Take Significant Action at Annual Meeting of S. P. E. E.

Record Attendance and Marked Enthusiasm for New Developments Result from War Experience and Dr. Mann's Report

Welcomed by an unusual paper by President Goodnow at Johns Hopkins University, members of the Society for the Promotion of Engineering Education held an enthusiastic series of discussions last week at the 27th annual meeting. Record attendance, a promising report on membership — there are now 1445 individual members and 70 institutions, the University of Texas being admitted this year — and an exceptional number of resolutions tending toward progressive and significant development in the society, especially in its relations to the other national societies and to the practicing engineer, marked the convention. Resolutions following recommendations in Dr. Mann's report on engineering education (see *Engineering News-Record*, Oct. 24, 1918, p. 742) and for the appointment of coördinating committees were adopted. The move to establish local sections of the society is pregnant for the future. The only criticism expressed was of the tendency toward long-winded discussion and the reading of papers of great length.

President Frank J. Goodnow, of Johns Hopkins University, delivered an address of welcome with the happy title "First Thoughts in Engineering Education," which seemed to strike the keynote of the convention. He raised the question as to the purpose of engineering education and discussed the three elements: (1) General education, which should be both intellectual and moral; (2) professional education, which should follow the "case" system as used in law and medical schools to give direct contact with world needs, and (3) research, principally to determine practicability for quantity production. In reply President John F. Hayford called attention to the fact that Johns Hopkins University was the earliest to start research in American universities, and that it had the youngest engineering college.

Mann Report Discussed

Most of the first session was devoted to the report of a special committee on the Mann report. This was presented by its chairman, W. E. Mott, in the form of six definite resolutions. All of these, except one, were carried after amendment or revision. The first recommended that, as a matter of experiment and research, psychological, "objective," "trade" or other similar tests be given to students after admission, the rating thus obtained to be compared with their subsequent scholastic progress. A supplementary resolution provided that this should be sent to all deans with the request that it be put into effect next autumn. Two papers explaining how these mental tests were applied aided greatly in the discussion—one by L. L. Thurston, Division of Personnel and Psychology, Carnegie Institute of Technology, and one by W. C. Magruder, of the Ohio State University.

The second resolution recommended the establishment and adoption of similar standards whereby the mental growth of students might be evaluated during the course of study. In reply to a question, it was explained that the engineering aptitude tests differ from ordinary examinations in the fact that the student has never been instructed in the subject matter of the test. The third resolution, providing for a limitation of the hours per week to 48 and the number of subjects requiring preparation to five, was lost principally because the preparation time for lecture hours was considered to be too indefinite and because of a fear of any impression that time requirements were limited and of supporting the idea of a labor union week.

Advise Business Training

The fourth and fifth resolutions were revised, amended and carried as follows: "4. That engineering students be required to pursue courses which will develop their business and administrative qualities. These courses should involve constant and continuous training in the use of English, both oral and written." "5. That the standing committee on mechanical engineering be requested to study and report to the society the most desirable methods of carrying on shop-work instruction for students pursuing engineering courses." The sixth resolution provided that the society should coöperate with the national engineering societies to establish a classification of work, or positions, including specifications as to preparation and qualifications so that undergradute students would have a clear understanding of the work for which they are preparing themselves, and instructors would have a constant reminder of the main purpose of their teaching work.

The exhaustive analysis of the "case" system for the study of law presented by Prof. C. F. Allen, Massachusetts Institute of Technology, clearly developed the application to engineering education—research for truth by the use of the corkscrew, not the ram-rod followed by the stomach-pump method. This and the symposium at the last session on the changes in curricula will be abstracted in detail in a later issue.

A significant resolution providing for the establishment of local sections of the society was passed unanimously, these sections to be fixed geographically. The

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Economic and Business Training for Engineers

Washington Conference of Prominent Educators and Representatives of Engineering Firms

At the final session of a two-day conference, held in Washington June 23-24, resolutions proposed by the conference committee of prominent educators were passed favoring the addition to engineering curricula of courses in general economics, cost accounting and business law and urging that the economic phases of engineering subjects should be emphasized in commercial instruction and that the institutions which have departments of engineering and economics or commerce be urged to consider some plan of coördination to develop a course to prepare students to meet the demand for large numbers of technically trained men for both foreign and domestic commerce.

This conference was called by the Commissioner of Education through Dr. Glen L. Swiggett, specialist in charge of commercial education in the Bureau of Education, and a representative committee of educators. There were about 155 present from all sections of the country, the discussion centering on the announced subjects of business training for engineers and engineering training for students of business, and on the results of the war experience as affecting technical education and foreign trade.

Engineering Salesmanship

At the first session, Dean Anson Marston, of Iowa State College, led the discussion on business training for the engineer. His paper will be abstracted in a later issue. Spencer Miller, vice president of the American Society of Mechanical Engineers and of the Lidgerwood Manufacturing Co., New York, placed first the need for developing character and outlined the qualities needed in engineering salesmen and the golden opportunities awaiting them. In the discussion was pointed out the danger of attracting too many men from the fields of design and research work, and the fact that it would be a mistake for all colleges to begin to train business engineers. Prof. G. H. Follows, head of the department of commercial engineering, Carnegie Institute of Technology, Pittsburgh, outlined by chart the course given in his department, and declared that a complete commercial training filled four years, it being almost impossible for men who had taken ordinary engineering courses to become managers of men.

Prof. Walter Rautenstrauch, Columbia University, in discussing engineering training for commercial enterprises, insisted that no worth-while instruction could be given without highly paid teachers. E. F. Dubrul, president of the Pyro Clay Products Co., Cincinnati, claimed that the science of business was as broad and its ethics as high as any profession, and that executives are highly paid because they control both the engineering production and the commercial or distribution phases of industry. Money will be provided by business men if the educator will show willingness to adopt new methods for supplying the kind of graduate they need—the course to be devised in conference. He called attention to the new college of engineering and commerce at the University of Cincinnati as offering a coöperative course of large promise.

War Experience and Education

The third session was devoted to the significance of the war experience for engineering education, a paper by Maj. Gen. John F. O'Ryan, of New York, being read by Mr. Swiggett.

Dr. Charles R. Mann, chairman of the advisory board, committee on education and special training of the War Department, pointed out that both army men and practicing engineers place character first. He raised the question as to just what is meant by the "fundamentals" which so many advocate, and claimed that these fundamentals are at once apparent if the army method of beginning with a definite job is followed. Thus the motive—motivation—is developed, and results follow because the student is doing something definite and learns to think on the job. Morale is a dominant factor, better than character as a test, and he would judge class work by group morale. The teacher should be a friendly investigator trying to lead the student to his best attainments rather than one who merely tries to meet certain set standards—and generally failing in a large proportion of cases. The classification and rating system of the army should be applied, helping to measure accomplishments.

The work of the Engineer School at Camp Humphreys was described by Dean Evans, Toledo University, who had inspected the work in mechanics and by Professor Hatt, of Purdue University, who inspected the work in engineering. Both testified to the evidence of high morale attained through the assignment of concrete problems, forcing the men to face a real design or investigation situation, used as the basis for developing principles. Professor Hatt emphasized the need for developing a science of education.

Improving Palo Verde Valley Levee System

The Palo Verde Joint Levee District on the lower Colorado River has completed, since October, 1918, about 13 miles of new levee and of standardizing work on old levees. Quarries have been opened up for revetment work to be undertaken soon. The district has voted $1,285,000 for a railroad track on the entire levee system which totals 34 miles in length. This is to be laid as part of the season's construction work after the subsidence of this year's river flood.

Contract Set for Westerly Sewage Works at Cleveland

After four years of experimental work and two years of discussion of the obtained results, Cleveland has awarded the contract for the construction of the westerly sewage treatment works. The Masters & Mullen Construction Co., of Cleveland, were the successful bidders at a price of about $678,000, and the work included comprises practically a complete plant with full equipment.

The westerly sewage plant is one of three that are proposed. It is designed to serve a population of 300,000. It is located on the west side of the city at the lake front near the Edgewater Bathing Beach; a condition which requires a higher degree of sewage treatment during the summer than during the remaining months of the year.

The plant comprises bar screens, grit chambers, two-story settling tanks, disinfection equipment and a submerged outfall. It is proposed to operate the bar screens, grit chambers and tanks the entire year, while the disinfection equipment will operate only during the bathing season. The settling tanks are designed with a detention period of 100 minutes.

During the earlier years of operation it is proposed to dispose of the sewage sludge by dumping it into the lake at the government dumping grounds. The dumping grounds are off the shore about three miles, and have been used for a considerable period for disposing of river dredgings. Should the barging of the sludge to the lake prove undesirable, land is available at the treatment site for sludge beds covered with greenhouse construction.

As the sewage plant is near one of Cleveland's large parks and well-traveled boulevards, particular care has been taken to harmonize the architectural features of the plant with the surroundings.

The contractor has stipulated July 1, 1920, as the time of completing the work. Robert Hoffman is city engineer and George B. Gascoigne sanitary engineer.

A. A. E. Gets Navy Engineers and Washington Office

The Navy Technical Association, consisting of 700 civilian engineers at the United States navy yards, has been amalgamated with the American Association of Engineers. The latter waived the entrance fees and will continue branches of the former in connection with its own chapters. The wide campaign that is being made in the interests of engineers in public service under Federal, state, county and municipal government has made it necessary to have a representative at Washington. The American Association of Engineers, therefore, has engaged R. C. Bradley, former president of the navy association, as its assistant secretary, with office at Washington.

Engineering Educators Meet

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two sessions devoted to the effect of war on engineering education and to military training in engineering schools, led by Dean Anson Marston, of Iowa State College, and by Col. F. J. Morrow, chairman of the committee on education and special training of the War Department, respectively, reflected the educators' reaction to war experience and furnished an opportunity to match minds with the military men. In the latter effort, certain definite questions by Pres. C. S. Howe, of the Case School of Applied Science, were read and partially discussed, but the army officers could not give definite information because the final ruling on the revision of general order 49 has not been made.

Colonel Morrow made a stirring plea for wide adoption of the college units of the Reserve Officers' Training Corps, stating that of 126 engineering schools of the country there were 99 who have established the R. O. T. C. units. He stated that 7000 officers per year would be required if plans for a 5,000,000 standing army matured. Maj. H. Tilghman described the work of the Artillery Corps, stating that for their men physical training could take the place of drill. A motion was carried expressing the thanks of the meeting to Colonel Moore and Major Tilghman, as well as the other army officers present, and also the high appreciation of the colleges for their work and the purpose to back up the movement for preparedness in case of further difficulties. Three new names were added to the committee appointed to coöperate with the War Department on this matter: A. L. Williston, Wentworth Institute; W. T. Magruder, Ohio State University, and W. M. Thornton, University of Virginia.

Training in English Emphasized

The report of the committee on English emphasized the value of constant supervision of English throughout the course, as at the University of Cincinnati, combined with coördination between the teachers of English and of other engineering subjects, the use of technical articles, training in debates, society papers, after-dinner speeches, etc. College English, according to Miss F. A. Harbarger, of New York City, should continue throughout the four-year course, for opportunity in self-expression, with insistence upon original ideas and training in the expression of those ideas. A definite philosophy of engineering should be developed.

Discussing the paper by Prof. George R. Chatburn, past president, on the history of the society, Prof. C. J. Tilden, who has just accepted the position as head of the department of applied mechanics, Sheffield Scientific School, Yale University, pointed out the need for a history of the engineering profession which could be used to inspire the students. Some discussion of the five-year course was started, and continued at the informal smoker the same evening; the general feeling seemed to be that the five- or six-year courses should be built as integral wholes in order to be successful, that relatively few students could afford to take them (in spite of Professor Flather's statement that 75% of the students at the University of Minnesota returned for the fifth year), and that the serious question whether such courses furnished the student with value received should be considered.

Dean E. O. Leuschner, University of California, asked for full coöperation with the committee on degrees of the Association of American Universities in setting up ideals and reducing the absurdly large number of degrees now offered in American colleges. A motion for a committee of five to so coöperate was carried.

The inspection trip to the United States Naval Academy on Friday gave opportunity to learn of the work of the students, and for inspection of the experiment station. At the banquet the preceding evening President Hayford urged as a slogan "Education for service as engineers," saying that emphasis should be placed alternately on specialization and general education, practice and theory.

College Administration Weaknesses

The feature of the last session was the address by Pres. Ira N. Hollis, of Worcester Polytechnic Institute, who preceded the interesting symposium on changes in engineering courses. He defined administration as everything that interferes with giving entire time to the education of the student, regretting every year in administration which he had been forced to take up, saying that it was not a promotion when a good teacher was given an administrative position. The whole future of an institution depends upon whether the teacher has leisure to properly prepare his courses.

The problem of the 20th century, he said, is the development of efficiency in the mass of humanity, any partial efficiency is worse than useless. The pernicious effects of the desire for selling at profit were emphasized. Boards of trustees, made up of manufacturers, have the wrong attitude, judging teachers by what they do outside of their class work; he is hoping to make an investigation to prove that the present business administration is radically wrong and in need of reformation. He claimed that nothing better has been developed since 500 B.C., when the Greek college master and disciple developed the best in literature, in art and laid the foundations of modern science. Every man who studied under Agassiz at Harvard University attained to eminence.

He cited the work of a committee of the American Society of Mechanical Engineers which proposes (1) a syllabus for work of students outside of the classroom, (2) to establish a number of scholarships in various universities and (3) to appoint a traveling investigator to visit all engineering colleges. In conclusion, he claimed that the time of the teacher to improve his courses should be definitely provided, no more half-time teachers who give full time to outside work should be tolerated. The students should present and discuss subjects not in the regular class work; engineering societies should encourage the educators in the broadening of the courses.

A resolution was carried by which the president is to appoint a committee for the purpose of coöperating with the national engineering societies in the formation of local student sections, and in the work of their committees on engineering education. A special vote of thanks to President Hollis was also carried over his protest.

A paper on "Visual Industrial Courses," by Prof. C. P. Bliss, of New York University, explains the progress made in developing moving picture courses, under an advisory board headed by Charles M. Schwab, by experts in film production and college professors.

The officers for the ensuing year are: Arthur M. Greene, Rensselaer Polytechnic Institute, president; A. A. Potter, Kansas State Agricultural College, vice-president; F. P. McKibben, now at Union College, Schenectady, N. Y., vice-president; F. L. Bishop, University of Pittsburgh, secretary; W. O. Wiley, New York City, treasurer.

Returned Units of the 23rd Engineers

The War Department at Washington reports that up to June 21 the following units of the 23rd Engineers had returned to this country: Cos. A, B, C, D, E, F, G, H, I, K, L, M; wagon Cos. 1, 2, 3, 4 and 5; train Cos. 1 to 10, inclusive.

Western Society of Engineers Holds Jubilee Meetings

Observance of the 50 anniversary of this society took the form of two meetings held on June 27 and a "family" picnic at "the dunes" of the south shore of Lake Michigan on June 28. A review of the society's history and development was presented by the secretary, E. S. Nethercut. The society was organized in May, 1869, under the name of the Civil Engineers Club of the Northwest and was incorporated under the present name in 1880. Charles Paine was the founder and the call for the first meeting was sent out by R. B. Mason, who was the first president.

Military preparedness combined with systematic athletic training as an economic necessity in preventing future waste of human life and energy was the keynote of an address by Col. Henry

A. Allen, 108th Engineers, who returned recently from France. Developments in special lines were the subject of addresses at the meeting: railway engineering, Samuel O. Dunn; steam power plants, J. R. Bibbins; electric light and power, J. R. Cravath; electrical communication, F. F. Fowle; sanitary engineering, John W. Alvord. Brief addresses were made also by some of the past presidents.

New York Public Service Engineers Hold Meeting

The Rapid Transit Engineers' Association, an organization of the employees of the Public Service Commission, First District, New York, discussed ways and means of obtaining increases in salary commensurate with the rise in the cost of living at the meeting June 25, noted in these columns last week.

The meeting resolved itself into a discussion as to the advisability of affiliating with the American Federation of Labor. The result was a decision to hold another meeting on July 14 at the Municipal Building, where unionization will be debated and later submitted to a referendum before affiliating with the A. F. of L.

The association was founded as a consequence of the wrangle between the Board of Estimate, New York City, and the Public Service Commission, resulting in the peremptory dismissal of some 300 engineers on Dec. 31, 1918.

City Wages Advance in Seattle

The Board of Public Works of the City of Seattle, Wash., according to a dispatch to the New York *Times* from Ole Hanson, mayor, was recently ordered by the mayor "to ascertain how much the cost of living had advanced since the signing of the armistice and to increase the wages of our 5000 employees in proportion." In the 15 months since he became mayor Mr. Hanson states that wages have been increased from $3.50 to $4 and then from $4 to $4.50 a day. He says further:

"Our employees must and shall be paid enough to live in decency and comfort. It is neither good business nor good morals to underpay any one. The number of dollars one receives for work is not the true measure. The question is —how much flour, beef, beans, rent, shoes, etc., these dollars will purchase. . . . . .

"No concerted demand has been made by city employees, nor should employers wait until forced by threats of strikes, etc., to do justice to their employees. If the workmen are entitled to better wages and living condition, give it to them without asking and without pressure. . . . . .

"Peace is now signed. Let us now give our best efforts to understand, if possible, to solve this great problem. When this problem is solved the greatest cause of unrest is wiped out."

U. S. Forest Products Laboratory Gets Chicago Support

Problems now facing the U. S. Forest Products Laboratory at Madison, Wis., were considered at a meeting organized by the Chicago Association of Commerce and held at the Union League Club on June 26, with about 40 representatives of engineering and architechtural societies and varied industries. Mr. Winslow, director of the laboratory, outlined the conditions as follows: Prior to the war the laboratory had an annual appropriation from Congress of $140,000 and employed something over 80 people. During the war this appropriation was supplemented by allowances from the War and Navy departments, while the number of employees was over 500. During 1918 the allowances from these departments aggregated about $700,000, but they were to cover specific investigations and were not as beneficial to trade in general as those which were carried on under the appropriation of $140,000.

A bill which has passed both the House and Senate appropriates $175,000 for the current year, which is insufficient to maintain the present organization. In addition, the laboratory is occupying buildings loaned by the State of Wisconsin and some of these must be vacated soon for the use of the University of Wisconsin. There is present need for an additional appropriation of $300,000 to carry on necessary industrial investigations, while about $500,000 will be needed later for a permanent home. It has been suggested that the laboratory be located in Chicago.

A resolution was passed for the appointment of a committee to present the matter to the industries affected, with a view to securing appropriations sufficient for carrying on the work of the laboratory.

State Will Build Grain Elevators

State construction and ownership of grain elevators, state manufacture of flour, a state bank, official state newspaper in each county and broad powers as to other industries being taken up by the State of North Dakota were authorized last week by some 7000 majority in a referendum vote on the Non-Partisan League program adopted by the Legislature last winter.

Civil Service Examinations

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Assistant designing engineer, Naval Ordnance Plant, South Charleston, W. Va., $9.20 per diem. July 8. File applications before July 8.

Assistant inspector of engineering material (aircraft), $5.92 per diem, July 15. File applications before July 15.

Chief ship draftsman, U. S. Navy Department, $10 to $12 per diem; draftsman, grade A, $8 to $9.60 per diem; draftsman, grade B, $6 to $7.20 per diem; draftsman, grade C, $5.20 per diem. No date specified. Applications should be filed without delay.

Chief draftsman, general engineering, architectural, power plant, heating and ventilating, electrical, U. S. Navy Department, $10 to $12 per diem; draftsman, grade B, $6 to $7.20 per diem; draftsman, grade C, $5.20 per diem. No date specified. Applications should be filed without delay.

Valuation engineer, $3600-$4800 per year, and assistant valuation engineer, $2500-$3600 per year; technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department. No date specified.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

NGINEERING SOCIETIES

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION; Tremont Temple, Boston; Sept. 30, Oct. 1-3. Albany, N. Y.

The Rochester Society of Technical Draftsmen was addressed by Leslie S. Wood, who spoke on experiences in construction work in the tropics, at the annual meeting, held June 26. The following officers were elected for the year: President, H. Hewes Sullivan; vice-president, Jesse C. Franklin; secretary, A. L. Angevine, Jr., Eastman Kodak Co.; treasurer, Arthur Hooper. Committees on employment, research, and publications were appointed.

The Pennsylvania Railroad Section of the American Association of Engineers held its first annual meeting in Pittsburgh June 28. W. C. Bolin, supervising pilot engineer, Baltimore & Ohio R.R., who has been actively engaged in connection with the hearings before the Wage Board of the United States Railroad Administration, addressed the meeting in reference to salary adjustments for railroad technical engineers. Other papers were: "What Can Be Done to Make the Railroad Engineer's Position More Attractive?" by C. V. Potter; "What Can the Railroad Section Do Toward Increasing the Professional Abilities of Its Members?" by H. M. Sommerville and C. W. Haasis;

"Should Construction Work Be Handled by the Division?" by S. O. Klinger, and "The Schedule of Salaries of the American Association of Engineers," by C. E. Adams. The following officers were elected: President, F. E. Sawyer; vice-presidents, A. L. Ware and C. V. Potter; secretary and treasurer, A. Sommerville.

The Elgin, Joliet & Eastern R.R. Section of the American Association of Engineers has been organized, with headquarters at Joliet, Ill., with the following officers: President, F. C. Stuart, signal engineer, E., J. & E. R.R.; vice-president, E. B. Scott, designing draftsman; secretary, R. D. Rogers, designer.

The Chattanooga Club of the American Association of Engineers adopted a constitution and by-laws at a meeting June 18, at which it was decided to petition the American Association of Engineers for a charter chapter. R. E. Elgen presented a paper on "The Individual's Duty to the Local Engineering Club." At the previous meeting J. L. Gotschall and H. B. Smith spoke on the purposes and aims of the club.

The Brownsville (Penn.) Club of the American Association of Engineers has been organized with the following officers: President, J. W. Boyd; vice-president, Charles L. Moore; secretary, R. G. Crippen; treasurer, M. F. Burt.

The Oregon Society of Engineers opened its new club rooms in the Tilford Building, Portland, at a meeting June 27.

The Austin (Tex.) Engineers' Club was recently organized with the following officers: President, R. G. Tyler, vice-presidents, F. E. Rightor and M. C. Welborn; secretary-treasurer, W. W. Carson, Jr.

PERSONAL NOTES

GEORGE ELLERY HALE, director, Mount Wilson Observatory, California, and foreign secretary, National Academy of Sciences, who for the last ten years has been a correspondent of the Academie des Sciences, Institut de France, has been elected Associe Etranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The number of foreign associates is limited to 12, the Americans being Simon Newcomb and Alexander Agassiz. Recently the National Research Council created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman, in recognition of his services to the National Research Council and to science and research in assisting the Government during the war.

E. C. MILLER, for the past two years testing engineer, Kilbourne-Clarke Manufacturing Co., Seattle, has resigned to enter partnership with his father, G. M. Miller, under the firm name of G. M. Miller & Son., engineers, and will specialize in hydraulic work, with offices in the Burke Building, Seattle.

COL. H. J. LAMBE, D. S. O., Canadian Expeditionary Forces, who was previously district engineer, Canadian Department of Public Works, has returned to Canada after four years and eight months' service overseas, and has been appointed superintending engineer, Province of Ontario, with headquarters at Toronto, with supervision of river and harbor work.

CARL B. ANDREWS, chief engineer, Oahu Railway & Land Co., has resigned to become associated with the Pampanga Sugar Development Co. to lay out a railway system to serve a central sugar mill in Manila, P. I. The properties of the company are in the central valley of Luzon, about 50 miles north of Manila, and the work is expected to cover a period of about a year and a half.

J. J. STALEY and T. H. MORRIS have become associated under the firm name of Staley & Morris, engineers, with offices at 2009 Market St., Philadelphia. In addition to conducting a general engineering practice, the firm is representing F. D. Cummer & Son Co., Cleveland; Littleford Bros., Cincinnati, and Edward F. Terry Manufacturing Co., New York City.

LOUIS D. FOUGUET, who for the past year has been engaged as advisory engineer for the firm of Day & Zimmermann, supervising engineers on the construction of the Philadelphia Quartermaster Terminal for the U. S. Army, has resigned to enter private business at Fishkill, N. Y. Mr. Fouget was engineer of outfitting basins during the construction of the Hog Island shipbuilding plant of the American International Shipbuilding Co., and from 1909 to 1916 was engineer of the Sewer Division, Public Service Commission, in the construction of the dual system of subways in New York City. He was previously assistant to the chief engineer of the Public Service Commission, First District. He expects to resume professional practice in August or September.

LIEUT. COL. ELMER K. HILES, Engineers, U. S. A., who went to France as a captain in the 15th Engineers, has just returned to this country after nearly two years' service. He will join the Pittsburgh Testing Laboratory, as manager of laboratories, with headquarters at Pittsburgh.

M. W. STRAIT, Zanesville, Ohio, has been appointed city engineer of Anderson, S. C.

C. T. FELPS, previously of the 23rd Engineers, A. E. F., has been appointed division engineer, State Highway Commission of Kansas.

PAUL C. GAUGER and E. O. KORSMO have become associated in partnership under the name of the Gauger-Korsmo Construction Co., and will engage in a general engineering and construction business, with headquarters in the Central Bank Building, St. Paul.

A. B. HUNGERFORD, who was appointed city engineer of Hudson, Kans., several weeks ago, has been appointed city manager.

G. C. STANLEY, assistant county highway engineer, Cherokee County, S. C., has been appointed highway engineer succeeding N. C. Hughes, resigned.

LIEUT. COL. CLARENCE S. SMITH, 107th Engineers, U. S. A., has received his discharge from the service and will return to his work with the Bates & Rogers Construction Co., Chicago, as manager of the Cleveland office.

GEORGE H. WILLITS, for the past two years city engineer of Galveston, Tex., has resigned to become assistant to J. F. Witt, county engineer, Dallas, Tex., and will aid in carrying out the roadbuilding program for which the county recently voted $6,500,000.

RAYMOND G. SHERMAN, superintendent, Deerfield River Power Co., has been appointed superintendent of the Connecticut River Power Co., both concerns being under the management of the New England Power Co.

T. J. BIVENS, principal assistant engineer, maintenance of way, Union Pacific R.R., has been appoined assistant division engineer, Nebraska division, with headquarters at Omaha.

O. J. EIDMANN, assistant bridge engineer, State Highway Commission of Kansas, has resigned to enter the Southwestern Engineering Co., with headquarters at Hutchinson, Kans.

A. S. MCFADDEN, assistant engineer, State Highway Commission of Kansas, has resigned to enter the Kansas Engineering Co., Topeka, of which he is one of the organizers.

WINSTON E. WHEAT, junior engineer, U. S. Engineer Office, Fort Barrancas, Fla., has been appointed county engineer, Escambia County, Fla., with headquarters at Pensacola.

C. C. JONES, formerly county engineer, Watunsee and Osage counties, Kansas, has been appointed division engineer for the State Highway Commission of Kansas.

OBITUARY

WILLIAM G. FORD, consulting engineer, Brooklyn, N. Y., died in New York City, June 23, at the age of 58. He graduated from the Naval Academy at Annapolis in 1881 and later left the Navy to enter the service of the U. S. Coast and Geodetic Survey. Afterward

he entered the New York State Fisheries Department, and in 1891 was placed in charge of survey work for New York City, preparing plans for the Manhattan and Queensborough bridges, for which he made the original surveys and triangulations. He also made the surveys for the Pennsylvania R.R. Hell Gate bridge. In 1894 he organized the Second Naval Batalion of Brooklyn, and about the same time was also engaged in the organization of the Brooklyn Engineers' Club, of which he was a past president. In 1907 he was appointed to the Jamaica Bay Improvement Commission, and served for four years

EMMETT PHILLIPS, a member of the California State Highway Commission, died in Sacramento, June 18, at the age of 52.

MAJ. JAMES NESBIT HAZELHURST, Engineers, U. S. A., who died in Brussels, Belgium, was born in 1864 and received his early education at Kirkwood Military Academy and the University of the South, Sewanee, Tenn. In 1884 Major Hazelhurst resigned as superintendent of construction of the New Orleans and Mississippi Valley Ry. to become manager of the Lookout Iron Works, Chattanooga, Tenn. In 1895 he was engineer in charge of design and construction of water-works and paving for the city of St. Augustine, Fla., later becoming chief engineer, Board of Public Works, Tampa, Fla. In 1900 he resigned to become chief engineer of the Miles Salt Co., New Orleans, and a year later was elected chief engineer of the Board of Public Works, city of Mobile, Ala., for a period of five years, after which he resigned to enter private practice in Atlanta, Ga. When this country entered the war he was commissioned as major of engineers and assigned to the staff of Maj. Gen. Leonard Wood, commander of the Department of the Southeast, as officer in charge of water-supply. In September, 1917, he was ordered overseas as principal assistant to the officer in charge of water-supply section at Chaumont, France, and was later transferred to Tours in the water-supply section. In October, 1918, he was ordered to the southeastern part of France as engineer officer in charge of construction and as water-supply officer, Base No. 6, including territory between the Riviera and the Italian frontier. Three months later he was ordered to Paris as a member of the American Commission to Negotiate Peace, assigned to the department of finance and economics of the War Damage Section, in the capacity of director of the division investigating damages to structures in Belgium.

JOHN C. FREY, contractor, Lafayette, Ind., died in that city, June 20. He had been engaged in the contracting business for some years in partnership with his brother, the late William F. Frey.

New Device Tightens and Clamps Wire Pipe-Bands

A new pipe-banding device, for use particularly in the construction and repair of wood-stave pipe, but adapted also to the repair of iron and steel pipe, is shown in the accompanying illustration. This shows the device as used to apply additional bands for reinforcing old wood-stave pipe. Leaks at decayed spots, or at the ends of new staves inserted for repair, may be stopped by

WIRE BANDS PLACED ON PIPE BY TIGHTENING DEVICE

applying a rubber gasket with a piece of wood stave or iron placed over it and held in place by one or two bands.

Galvanized steel No. 4 or No. 6 wire is used, cut to length and having one end bent and twisted to form a loop. This is placed around the pipe, the free end being passed through the loop and into the barrel of the machine, where it is clamped. With one hand holding the machine barrel, the ratchet lever is worked by the other hand to draw the wire tight. Then the machine is turned over to the opposite direction from that shown, thus clamping the wire on the loop. The machine is then released, the wire cut off and the end hammered down, which completes the operation.

This tool is the invention of R. H. Corey, general manager of the Coos Bay Water Co., Marshfield, Ore. It is manufactured by the Corey Mfg. Co., of that city.

BUSINESS NOTES

THE WATSON-STILLMAN CO., of New York City, have removed their general sales and advertising department from Aldene, N. J., to 50 Church St., New York City.

THE LIGHT RAILWAY EQUIPMENT CO., of Pittsburgh, Penn., has been acquired and is controlled by the L. B. Foster Co., of Pittsburgh, and a new factory has been completed at Holmes, near Philadelphia, Penn. The company specializes in light rails, frogs, switches, portable and industrial tracks, turntables, dump-cars, flat-cars, coal-charging cars, and manufactures industrial cars of special designs. It also acts as consulting engineer in studying transportation problems in industrial plants. H. A. Ellis is in charge of the manufacturing, while B. H. Behrens, formerly connected with the Koppel Co., will handle sales.

THE CAMP CONDUIT CO., the BARKWILL-FARR CO., and the CLEVELAND BUILDERS SUPPLY CO., all of Cleveland, Ohio, have amalgamated. The purpose of the amalgamation is to facilitate the distribution of brick made by the Camp organization.

THE LEWIS F. SHOEMAKER & CO., manufacturers of steel bridges and building, Pottstown, Penn., has changed its corporate name to Shoemaker-Satterthwait Bridge Co., effective July 1, 1919. The management and personnel remain unchanged.

THE MCMYLER-INTERSTATE CO., of Cleveland, Ohio, announces that it has opened a branch office in San Francisco, in the Merchants Exchange Bldg., with L. A. Somers in charge. Mr. Somers has had considerable experience in sales, having been sales manager of various large companies.

TRADE PUBLICATIONS

The following companies have issued trade publications:

THE AUSTIN CO., industrial engineers and builders, of Cleveland, Ohio; catalog 11 x 8½ in., 63 pages, illustrated; explains the Austin method of factory construction, including engineering data and descriptions of the 10 types of Austin standard factory buildings.

THE KOEHRING MACHINE CO., Milwaukee, Wis.; folder, 7 x 8 in., 9 pp., illustrated; describes small concrete mixers equipped with light duty hoists.

THE BASTIAN-BLESSING CO., of Austin Ave. and La Salle St., Chicago, Ill.; catalog, 8 x 10 in., 36 pp., and booklet, 4 x 9 in., 10 pp.; describes a new type of welding and cutting apparatus.

THE AMERICAN TRUCK BODY CO., of Martinsville, Va.; booklet 3½ x 8½ in., 8 pages, and an illustrated folder; both describe the "Fontaine" demountable truck body.

THE R. D. NUTTAL CO., 2133 Conway Bldg., Pittsburgh, Penn.; booklet, 6 x 8¾ in., 16 pp., illustrated; describes the various kinds of gears manufactured by the company.